0054789

BHI-01462
Rev. 0

Well Deepening and Supplemental Vadose Zone Characterization at the Hanford 200 West Area 216-Z-9 Trench

Prepared for the U.S. Department of Energy, Richland Operations Office
Office of Environmental Restoration

Submitted by: Bechtel Hanford, Inc.

THIS PAGE INTENTIONALLY
LEFT BLANK

BHI-01462
Rev. 0
OU: 200-ZP-2
TSD: N/A
ERA: Carbon Tet.

APPROVAL PAGE

Title: Well Deepening and Supplemental Vadose Zone Characterization at the Hanford 200 West Area 216-Z-9 Trench

Approval: G. B. Mitchem, Groundwater/Vadose Zone Integration Project, Senior Task Lead

Signature: [signature] Date: 3/15/01

L. R. Curry, Groundwater/Vadose Zone Integration Project Engineer

Signature: L. R. Curry Date: 3/15/01

M. N. Jarayssi, Groundwater/Vadose Zone Integration Project, Environmental Lead

Signature: L. R. Curry for MNJ Date: 3/15/01

R. L. Jackson, Groundwater/Vadose Zone Integration Project, Task Lead

Signature: R L Jackson Date: 03/14/01

The approval signatures on this page indicate that this document has been authorized for information release to the public through appropriate channels. No other forms or signatures are required to document this information release.

BHI-DIS MAR 15 2001

THIS PAGE INTENTIONALLY
LEFT BLANK

BHI-01462
Rev. 0

Well Deepening and Supplemental Vadose Zone Characterization at the Hanford 200 West Area 216-Z-9 Trench

Author

C. W. Miller
CH2M HILL Hanford, Inc.

Date Published

March 2001

THIS PAGE INTENTIONALLY
LEFT BLANK

EXECUTIVE SUMMARY

The Environmental Restoration Contractor will deepen and reconfigure two existing vadose zone wells in the 200 West Area of the Hanford Site. These wells will be modified in fiscal year 2001 by drilling through the existing well bottom and installing new screened intervals within the vadose zone. The reconfigured wells will enhance performance of the existing soil vapor extraction (SVE) system located in the vicinity of the 216-Z-9 Trench at the Hanford Site's Plutonium Finishing Plant (located in the 200-PW-1 Operable Unit, which is regulated under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*). Based on historical records, the 216-Z-9 Trench was one of three major locations discharging radioactive liquid organic waste, including carbon tetrachloride, to the ground in the 200 West Area.

The objectives of the well reconfiguration activity are as follows:

- Place additional SVE screens below the Plio-Pleistocene unit at elevations where high concentrations of carbon tetrachloride were detected and SVE modeling indicates the potential for localized areas of relatively low air flow during SVE operation

- Collect and analyze soil and soil vapor samples to provide additional information regarding the extent of residual soil contamination below the 216-Z-9 Trench.

Two existing SVE wells (299-W15-84 and 299-W15-95) will be extended from their current depths of approximately 30.5 m (100 ft) to depths of approximately 59 to 62 m (193 to 202 ft). New screened sections will be placed in the wells at selected intervals to support SVE. The screened intervals will be located in the Ringold Unit E beneath the Plio-Pleistocene unit, which forms a restricting layer to vertical flow within the vadose zone in the contaminated area. The additional vapor extraction intervals beneath the Plio-Pleistocene unit are expected to improve recovery of residual carbon tetrachloride from the vadose zone. The direct observations and the analysis results from the well soil samples will support refinement of the contamination conceptual model for the site.

TABLE OF CONTENTS

APPENDICES

FIGURES

TABLES

ACRONYMS

COC	contaminant of concern
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
ERC	Environmental Restoration Contractor
ERDF	Environmental Restoration Disposal Facility
ID	inside diameter
OD	outer diameter
PFP	Plutonium Finishing Plant
PNNL	Pacific Northwest National Laboratory
PPE	personal protective equipment
ppmv	parts per million by volume
SAI	sampling and analysis instruction
SSWMI	site-specific waste management instruction
SVE	soil vapor extraction
VOC	volatile organic compound

METRIC CONVERSION CHART

Into Metric Units			Out of Metric Units		
If You Know	*Multiply By*	*To Get*	*If You Know*	*Multiply By*	*To Get*
Length			**Length**		
inches	25.4	millimeters	millimeters	0.039	inches
inches	2.54	centimeters	centimeters	0.394	inches
feet	0.305	meters	meters	3.281	feet
yards	0.914	meters	meters	1.094	yards
miles	1.609	kilometers	kilometers	0.621	miles
Area			**Area**		
sq. inches	6.452	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.093	sq. meters	sq. meters	10.76	sq. feet
sq. yards	0.0836	sq. meters	sq. meters	1.196	sq. yards
sq. miles	2.6	sq. kilometers	sq. kilometers	0.4	sq. miles
acres	0.405	hectares	hectares	2.47	acres
Mass (weight)			**Mass (weight)**		
ounces	28.35	grams	grams	0.035	ounces
pounds	0.454	kilograms	kilograms	2.205	pounds
ton	0.907	metric ton	metric ton	1.102	ton
Volume			**Volume**		
teaspoons	5	milliliters	milliliters	0.033	fluid ounces
tablespoons	15	milliliters	liters	2.1	pints
fluid ounces	30	milliliters	liters	1.057	quarts
cups	0.24	liters	liters	0.264	gallons
pints	0.47	liters	cubic meters	35.315	cubic feet
quarts	0.95	liters	cubic meters	1.308	cubic yards
gallons	3.8	liters			
cubic feet	0.028	cubic meters			
cubic yards	0.765	cubic meters			
Temperature			**Temperature**		
Fahrenheit	subtract 32, then multiply by 5/9	Celsius	Celsius	multiply by 9/5, then add 32	Fahrenheit
Radioactivity			**Radioactivity**		
picocuries	37	millibecquerel	millibecquerel	0.027	picocuries

1.0 INTRODUCTION

This document describes the activities to be conducted by the Environmental Restoration Contractor (ERC) for vadose well modifications and sampling and analysis for site characterization, enhancing the existing soil vapor extraction (SVE) system, and characterizing wastes for disposal. For completeness, this document includes both the data quality objective (DQO) summary report and the well construction variance request as appendices.

1.1 SITE BACKGROUND AND REMEDIAL ACTION OPERATING HISTORY

The 216-Z-9 Trench (Z-9 Trench) is an engineered waste disposal facility designed to discharge liquid wastes to the soil column. The Z-9 Trench received liquid wastes generated by the plutonium recovery process at the Hanford Site's Plutonium Finishing Plant (PFP). The process was used to recover plutonium from residues of the plutonium metal-reduction processes used at the PFP, and wastes were disposed to the Z-9 Trench from 1955 to 1962. Waste streams discharged to the Z-9 Trench included large quantities of plutonium-contaminated wastewater and organic liquid mixtures. The organic mixtures included up to 300,000 L (79,200 gal) of carbon tetrachloride, 27,900 L (7,366 gal) of tributyl phosphate, and 46,500 L (12,276 gal) of dibutyl butyl phosphonate. Most of the organic contaminants at the Z-9 Trench were disposed as radiologically contaminated spent solvent mixtures, consisting of either 85:15 volume percent carbon tetrachloride to tributyl phosphate or 50:50 volume percent carbon tetrachloride to dibutyl butyl phosphonate. Lard oil was also disposed to the trench. The principal radiological contaminants at this site are plutonium and americium.

Carbon tetrachloride has migrated to groundwater beneath the site, and residual organic in the soil column beneath the Z-9 Trench is suspected as a potential continuing source of groundwater contamination. A comprehensive summary of the soil and groundwater contamination related to the Z-9 Trench and other nearby disposal facilities is presented in *1994 Conceptual Model of the Carbon Tetrachloride Contamination in the 200 West Area at the Hanford Site* (Rohay 1994).

In response to the need for control and removal of residual contamination sources in the vadose zone, an SVE system was installed in the vicinity of the Z-9 Trench and began operation in 1993. During the operating period from 1993 through September 1999, the carbon tetrachloride concentration in soil vapor at the Z-9 Trench SVE system declined from 30,000 parts per million by volume (ppmv) to approximately 25 ppmv. An estimated 53,000 kg (116,865 lb) of carbon tetrachloride were removed from the Z-9 Trench SVE well field during the same time period (Rohay 2000).

The SVE operations have removed residual organic contamination from a substantial soil volume beneath the Z-9 Trench. The Plio-Pleistocene unit, a fine-textured paleosol containing a fine soil layer and an underlying accumulation of caliche (amorphous calcium carbonate), is approximately 5 m (16.4 ft) thick beneath the Z-9 Trench and is encountered at a depth of approximately 32 m (105 ft) below ground surface. Carbon tetrachloride concentrations in soil vapor collected from above the Plio-Pleistocene unit have typically been higher than concentrations in soil vapor near the water table. Although the Plio-Pleistocene unit is generally recognized as a restriction to vertical flow in the vadose zone, it is not impermeable and substantial concentrations of carbon tetrachloride have been detected in soil vapor extracted from soil beneath the unit. This condition suggests that the Plio-Pleistocene unit may be locally discontinuous in the vicinity of the Z-9 Trench, exhibits varying permeability in the study area, or may have pathways introduced from old boreholes.

1.2 SCOPE AND OBJECTIVES OF PLANNED ACTIVITIES

The scope and objectives of the current well-deepening activity are described in the following subsections.

1.2.1 Scope

The scope of activities covered by this document is limited to modification of two existing vadose zone wells to a configuration that will support SVE in the stratigraphic zone between the Plio-Pleistocene paleosol and the unconfined water table beneath the site. Well configuration activities will include drilling to deepen the subject wells to the desired depth and placing screened intervals within the lower interval (as shown in Figure 1-1). Existing wells 299-W15-84 and 299-W15-95 will be deepened and reconfigured.

Sampling and analysis planning for this activity is focused on the following data needs:

- Characterization of residual contamination (e.g., organic compounds, radionuclides, and toxic metals) above, within, and below the Plio-Pleistocene unit
- Measurement of the concentration of volatile organic compounds (VOCs) in soil vapor at discrete elevations within the borehole
- Assessment of investigation-derived waste (e.g., drill cuttings) for proper waste management and disposal.

Scoping documents prepared to support this activity include this document, the DQO summary report, and a sampling and analysis instruction (SAI).

1.2.2 Objectives

The overall project objectives of the well-deepening activity are to collect and analyze samples to support characterization of the subsurface contamination at the site and to provide vadose zone wells configured for use as SVE wells. The specific objectives of the well deepening are identified as follows:

- Collect subsurface soil samples across the Plio-Pleistocene unit

- Measure VOC concentrations in soil vapor at discrete depth intervals during drilling
- Prepare wells with screened intervals that can be used for SVE below the Plio-Pleistocene unit
- Maintain the SVE functionality of the existing perforations in the two wells in addition to constructing the new screened intervals.

The rationale for well selection and the design basis for well reconfiguration (based on these objectives) are discussed in the following subsections.

1.2.3 Well-Deepening Rationale

Two wells (299-W15-84 and 299-W15-95) are identified for deepening and reconfiguration. These wells will be configured for use in the SVE well network. The following discussion provides the rationale for soil sampling intervals and initial selection of screened intervals for well reconfiguration.

The Z-9 Trench is one of the major source areas for historical release of carbon tetrachloride waste to the ground in the 200 West Area. The existing SVE system has removed a substantial quantity of organic contamination from the vadose zone beneath the trench. However, the quantity of residual contamination in the vadose zone is not easily determined based on existing information. Contaminated soil beneath the Plio-Pleistocene unit and above the water table is of particular interest as a potential continuing source of carbon tetrachloride contamination to groundwater. This portion of the vadose zone is approximately 32 m (105 ft) thick. Deepening two existing vadose zone wells and reconfiguring them with screened intervals placed lower in the vadose zone is a cost-effective approach to enhancing the existing SVE systems area of influence.

Seven existing SVE wells are screened beneath the Plio-Pleistocene unit. Only one well, however, is presently screened in the upper portion of the Ringold Unit E immediately beneath the Plio-Pleistocene unit. The remaining six wells that are screened in the lower portion of the unsaturated Ringold Unit E provide SVE coverage on the north, east, and south sides of the trench; however, none are located on the west side of the Z-9 Trench (Figure 1-2). Rohay and McMahon (1996) evaluated a numerical model of air flow and differential pressure within the vadose zone affected by the SVE system. The modeling indicates that airflow stagnation zones are expected at numerous locations and elevations within the vadose zone.

A stagnation zone was described within the Ringold Unit E beneath the Plio-Pleistocene unit, near the location of well 299-W15-95. This suggests that extending a well to depth at that location may increase the carbon tetrachloride removal from that zone. Another stagnation zone was identified within the fine-textured Hanford formation above the Plio-Pleistocene unit, in the vicinity of well 299-W15-95. This suggests that this location is of interest for evaluation of residual carbon tetrachloride above and within the Plio-Pleistocene unit. The magnitude of airflow stagnation zones was shown to vary with the selection of wells operating under SVE.

An additional stagnation zone was identified within the fine-textured Hanford formation above the Plio-Pleistocene unit, in the vicinity of well 299-W15-84. Samples collected and analyzed from above and within the Plio-Pleistocene unit at this location may provide useful information regarding the effectiveness of SVE at the west side of the Z-9 Trench. The deepened wells will be completed with screened intervals across an elevation interval wherein the highest soil concentrations of carbon tetrachloride were detected during initial site characterization (i.e., based on concentrations measured in other wells).

1.2.4 Reconfigured Well Construction Design Basis

Wells 299-W15-84 and 299-W15-95 will be deepened and reconfigured for long-term use as extraction wells in the SVE system. The rationale for selecting these two wells was presented in Section 1.2.3. The intent of the deepening activity is to construct new screened intervals at deeper levels. The existing perforated casing in the wells will be retained with possible SVE functionality. The following functional requirements have been identified for the reconfigured well design:

- Provide air flow for SVE with acceptable head loss
- Maintain access to, and functionality of, existing perforated intervals on reconfigured wells
- Provide sufficient annular space between temporary and permanent casing for placing filter pack and cement/bentonite sealing material
- Minimize entrance of formation sand into the screened interval
- Prevent contaminant movement across natural barriers (i.e., the Plio-Pleistocene unit)
- Provide favorable air circulation across specific elevation ranges.

The diameter of the well casing that can be installed in the deepened wells is constrained by the diameter of the existing well casing (i.e., 8-in. inside diameter [ID]). The deepened portion of the wells will be completed using a 2-in. or 3-in.-ID, stainless-steel, flush-threaded well casing inside a 6-in.-ID temporary casing. The selection of 2-in. or 3-in. casing will be based on constructability of the well. If it is determined that successful placement of the grout seal is less likely using a 3-in. casing, then a 2-in. casing will be used. Drilling requirements are discussed in Section 2.2.2. Screens for the deepened portion of the wells will be 0.020-in. (20-slot) stainless steel, vee-wire-wrapped screens. This screen size was selected based on past experience with SVE wells completed in the unsaturated Ringold Unit E. The appropriateness of the screen size will be confirmed after drilling and prior to screen installation. The nominal screen lengths will be 9.1 m (30 ft), equivalent to the screen lengths in other existing vadose zone wells at the same elevation in the vicinity of the Z-9 Trench. The planned new screened interval elevations for both wells will be approximately 154 m (505 ft) to 145 m (475 ft) above mean sea level. If elevated VOC concentrations are defined at other elevations by characterization during drilling, then completion of the well(s) at the elevation of highest VOC concentration will be considered. A 2-in. or 3-in.-ID casing will provide efficient SVE capacity with minimal head loss in the pipe while maintaining effective SVE capacity in the existing annular space between the new casing and the existing 8-in. casing.

A sand filter pack will be constructed for each screened interval to match the formation encountered. Well construction will include sealing the borehole through the Plio-Pleistocene unit with cement grout and placing a cement grout seal at the bottom of the existing 8-in. casing to ensure the continued integrity of the existing perforations.

Figure 1-1. Location of Extraction and Monitoring Wells at the 200-PW-1 Carbon Tetrachloride Soil Vapor Extraction Sites.

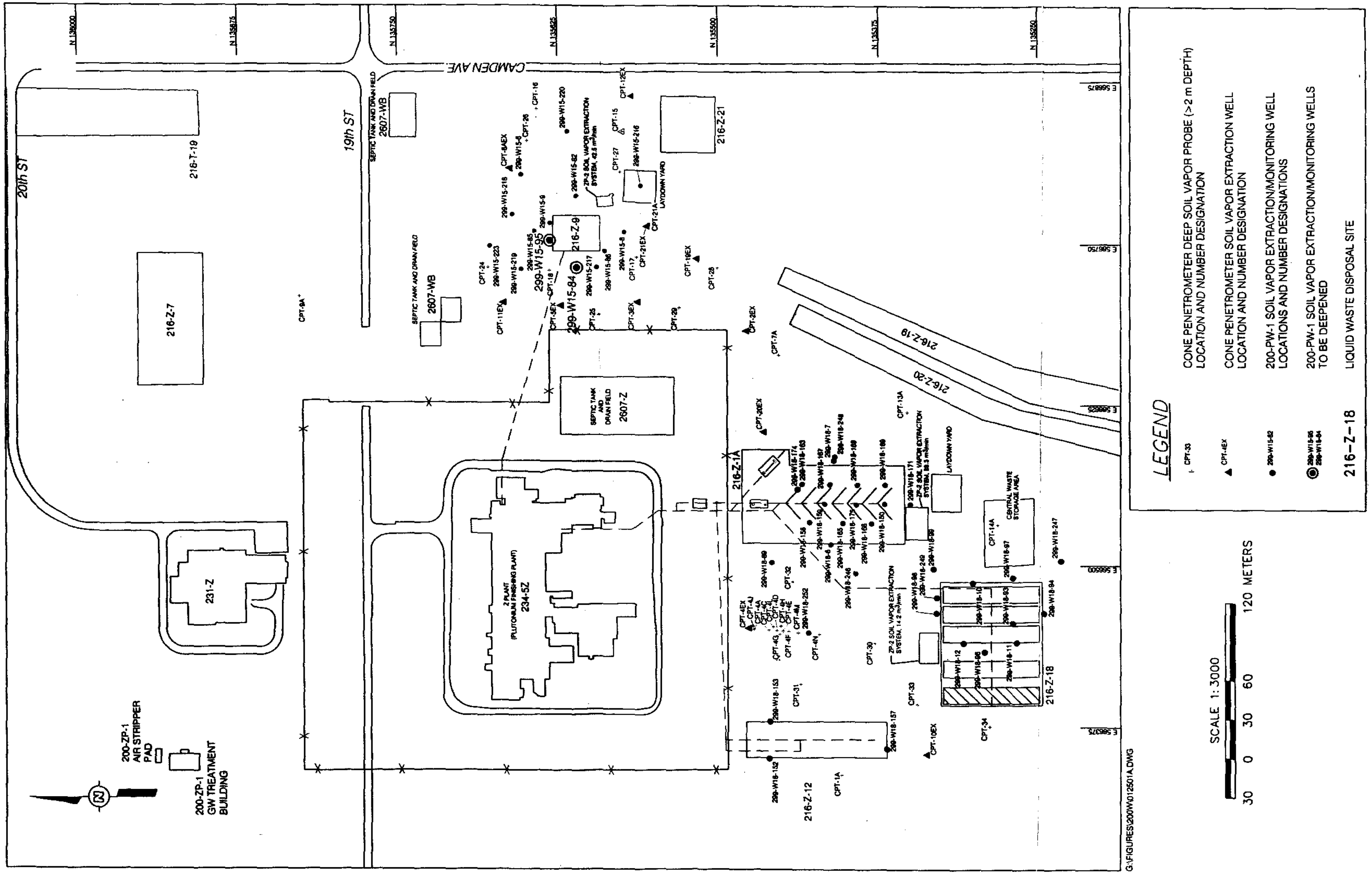
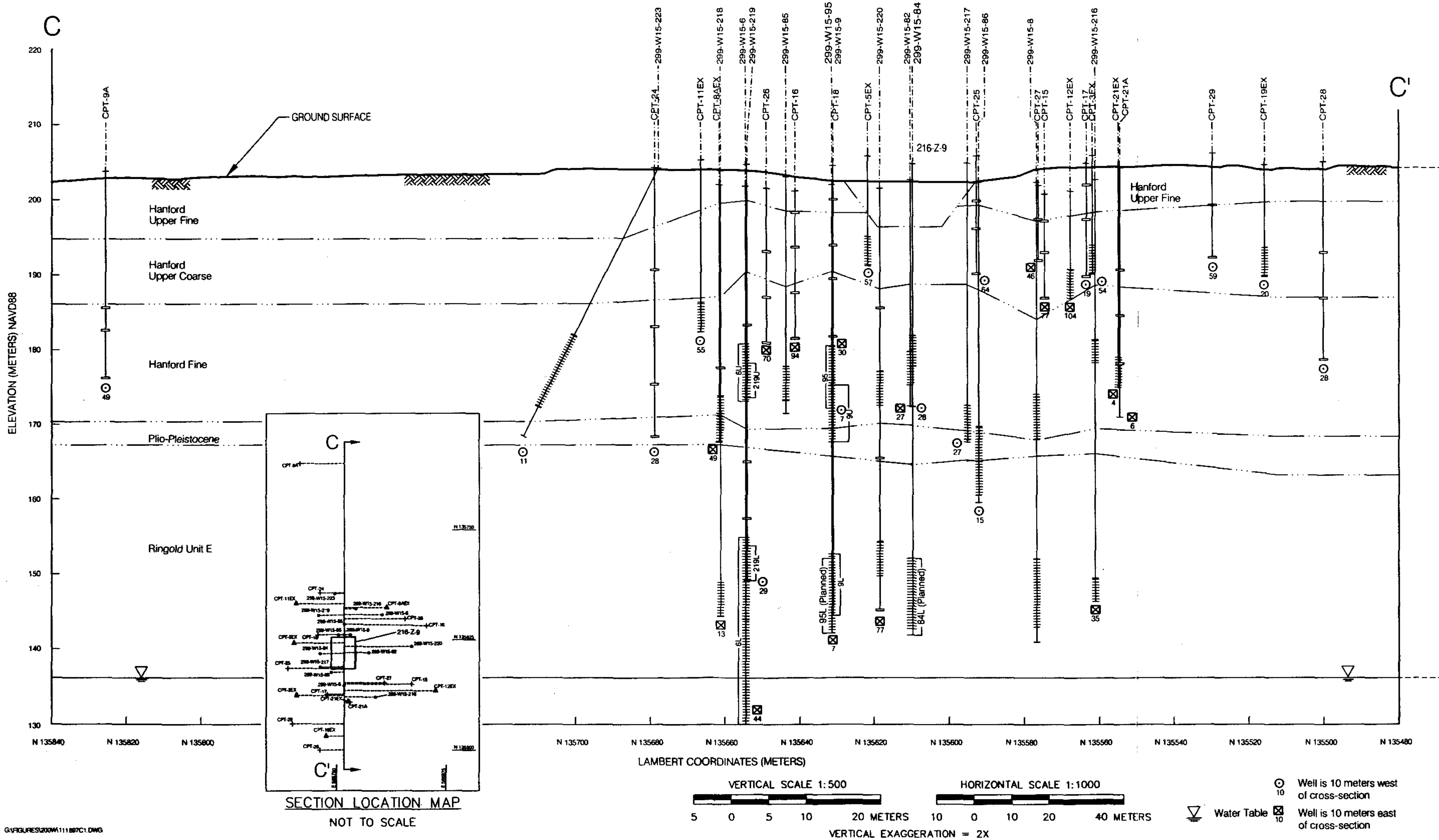


Figure 1-2. Generalized Cross Section in the Vicinity of the 216-Z-9 Trench.



2.0 BOREHOLE DESIGN AND INSTALLATION

Well-deepening requirements have been developed with consideration of site characterization needs and SVE operation. The configuration of the existing wells and the required modifications are described in the following sections.

2.1 LOCATION AND CONFIGURATION OF EXISTING VADOSE ZONE WELLS

The two existing wells requiring deepening are wells 299-W15-84 and 299-W15-95. The locations of these wells relative to the Z-9 Trench are shown in Figure 2-1. Well construction logs for the subject wells are presented in Appendix A. The relative elevations of the wells and selected features of their existing configuration are shown in Figure 2-2.

2.2 WELL MODIFICATION REQUIREMENTS

In general, the required modifications include extending the total depth of the subject vadose zone wells and installing new screens at selected intervals within the deep vadose zone. The details of the modifications are described in the following subsections. The wellheads for the modified wells will be configured to provide SVE connections to either the upper or lower screened interval as desired.

2.2.1 Well-Specific Modifications

Wells 299-W15-84 and 299-W15-95 will be extended approximately 27.58 and 27.55 m (90.5 and 90.4 ft), respectively, for completion with screened intervals in the lower portion of the Ringold Unit E above the water table. The screen placement is intended to match screened intervals of existing wells. The planned drilled depths, final total depths, and screened intervals are presented in Table 2-1.

Each of the wells to be modified requires drilling to a greater depth than the current total depth, installing a new screen at a selected interval in the vadose zone, and constructing the well to the surface with new casing. Drilling requirements are described in Section 2.2.2.

2.2.2 Drilling Requirements

The subject wells have been inspected using the following techniques and were found to be usable for the planned well-deepening activity:

- A downhole camera survey (to inspect the well for gross defects and the presence of foreign objects) was conducted in each well. Accumulations of a few feet of precipitates and corrosion products appear to be present at the bottom of the wells; however, the accumulations do not appear to be of sufficient volume or density to prevent drilling.

Substantial corrosion is apparent on the inside of the existing casing in both wells. No foreign objects were observed in the wells.

- A straightness test was performed for each well. The straightness test required passage of a length of 6-in.-ID pipe with a minimum length of 6 7/8-in outer diameter (OD) (20 ft) through the entire depth of the well. Both wells passed a straightness test, indicating that the existing casing should not interfere with placement of either the temporary 6-in.-ID well casing or the 2-in. or 3-in. permanent casing.

One additional candidate well, 299-W15-82, was also inspected using the downhole camera. This well exhibited severe corrosion, possible casing failure, and accumulation of approximately 10 m (30 ft) of corrosion products and/or chemical precipitates in the lower portion of the well. The well was not considered further for this current activity.

The wells will be extended using commercially available drilling techniques. Because of the potential for encountering subsurface radiological and/or chemical contamination, drilling will be performed using the cable-tool method. Summaries of the drilling requirements and well construction materials are presented in Tables 2-1 and 2-2, respectively. The screen slot sizes were selected to match formation particle size distribution in the target interval(s) based on existing knowledge of the formation from nearby wells, and will be confirmed from samples collected during drilling. Placement of a temporary 6 7/8-in.-OD casing within the existing casing is required to both protect the existing casing from damage and to allow construction of the new 2-in. or 3-in. ID well casing. A schematic of the reconfigured wells is shown in Figure 2-3.

The well construction for these deepened vadose zone wells does not meet the minimum construction standards for resource protection wells as specified in *Washington Administrative Code* 173-160, Part Two, "General Requirements for Resource Protection Wells." Specifically, the largest possible borehole (i.e., 6 in.) that can be advanced through the existing casings is not 4 in. greater in diameter (as required by *Washington Administrative Code* 173-160) than a 3-in. ID permanent well casing. A 2-in.-thick annular cement/bentonite seal is required between the formation and the permanent casing. In this case, the seals will be less than 1.5 in. thick. Therefore, a well construction variance application to construct wells with less than the statutory 2-in. annular space was submitted to the Washington State Department of Ecology for review and approval. The approved variance is presented in Appendix B of this document.

Well construction will require sealing the boreholes across the Plio-Pleistocene unit. Well and formation seals will consist of neat Portland cement with 5% bentonite. Cement grout seals are preferred over bentonite seals for this application due to the potential for dehydration of straight bentonite seals when the SVE system is operating. Perched water has been previously observed in wells in the vicinity of the Z-9 Trench above the Plio-Pleistocene unit; however, perched water is not expected during this drilling activity due to the discontinuation of discharges to the ground at the Hanford Site and the drying action of the SVE system. Drillers and field personnel must be alert for the presence of perched water, radiological contaminants, or phase-separated solvent. If any of these conditions are encountered, drilling will be halted while the situation is evaluated to determine the appropriate course of action. All alternative actions will be agreed upon by the U.S. Department of Energy and the U.S. Environmental Protection Agency (EPA).

Figure 2-1. Well Locations Relative to the 216-Z-9 Trench.

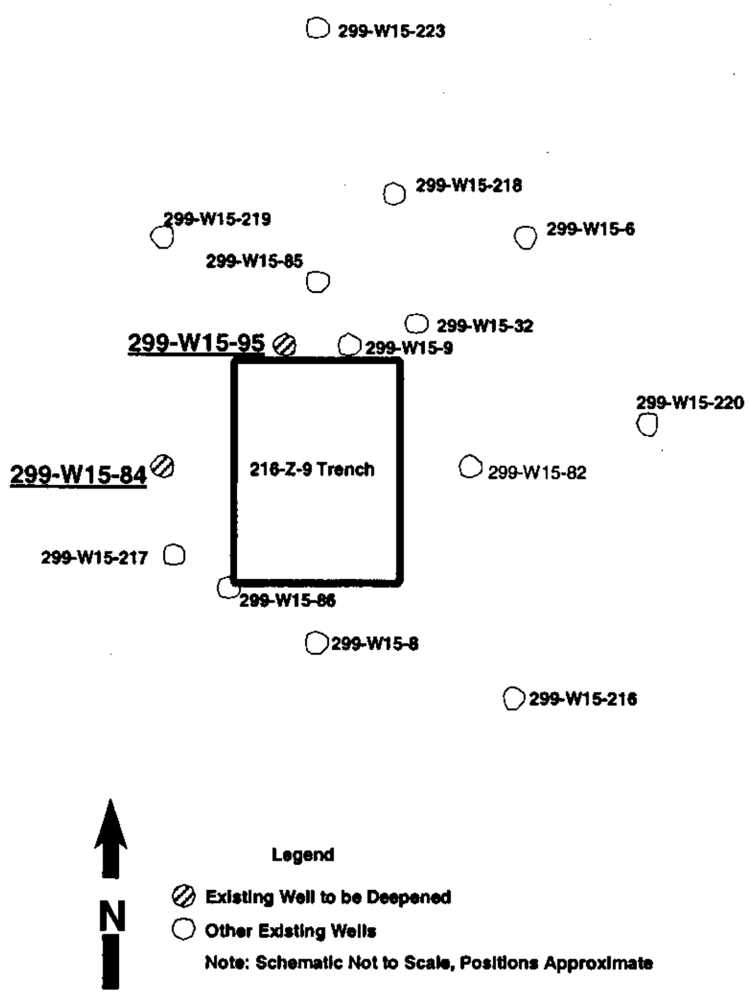


Figure 2-2. Well Elevations and Selected Features of the Existing Configuration.

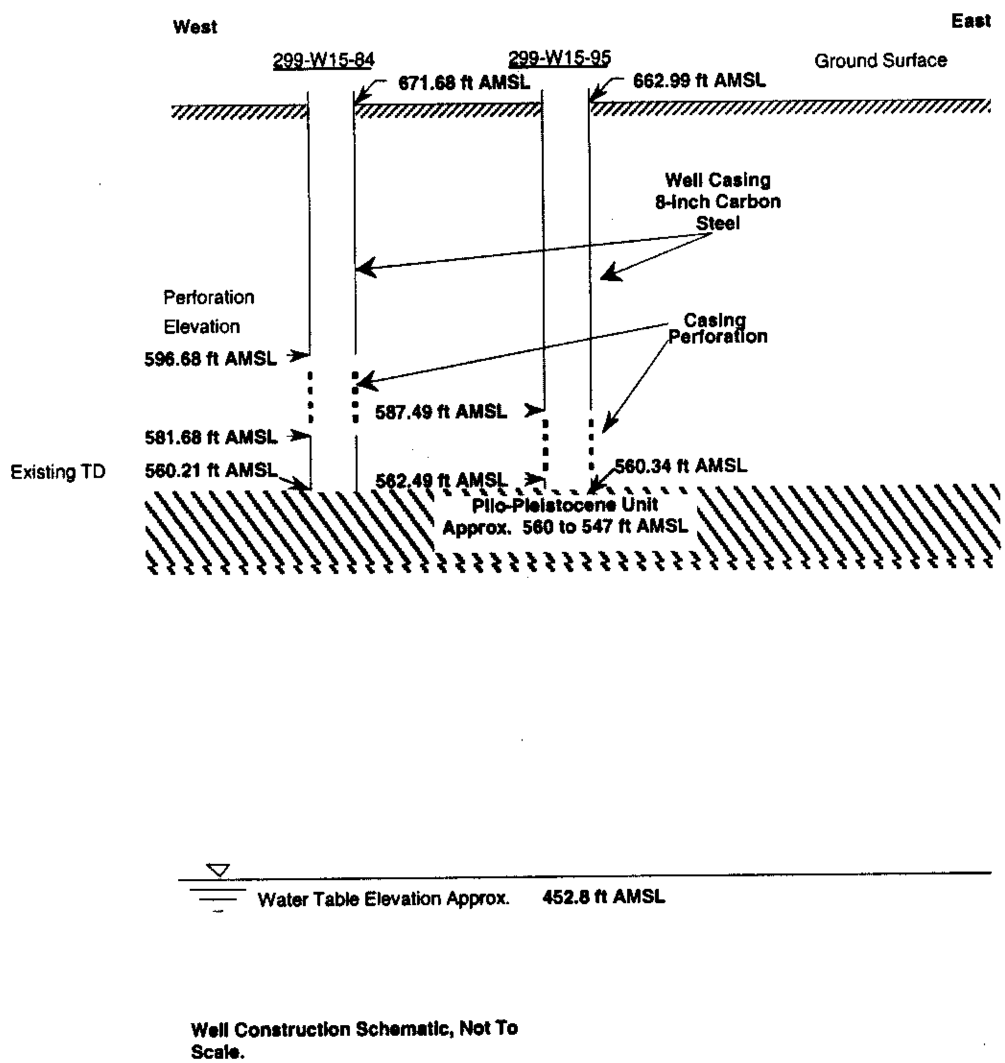


Figure 2-3. Schematic of Reconfigured Wells.

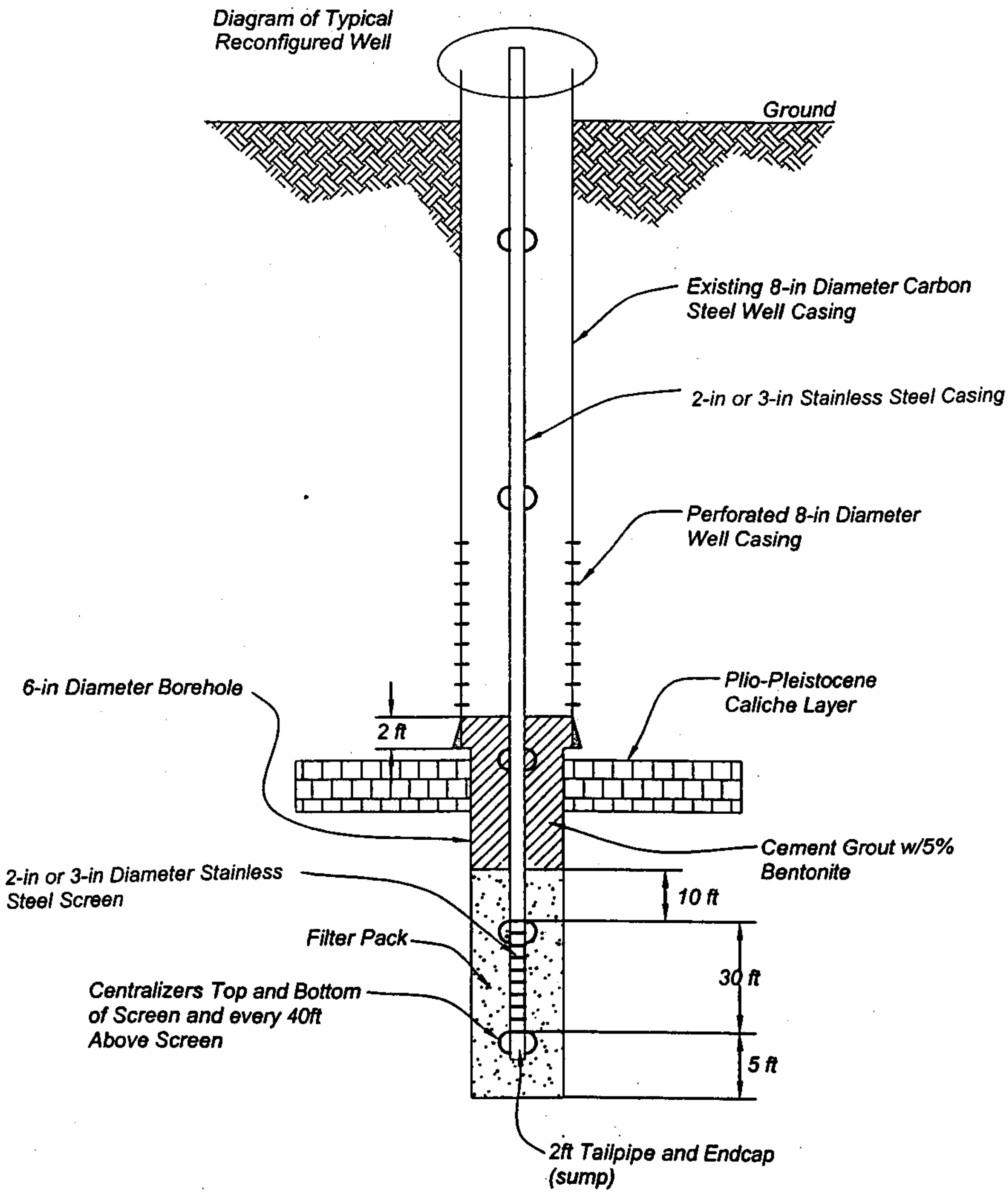


Table 2-1. Drilling and Casing Requirements for Well Reconfiguration.

Well Feature	Well 299-W15-84	Well 299-W15-95
Total depth of existing borehole and 8-in. ID casing (ft bgs)	111.5	102.6
Approximate depth to water (ft bgs) (for reference only)	219	210
Approximate total depth for reconfigured well (ft bgs)	202	193
Approximate length of temporary 6-in. ID casing (ft)	202	193
Newly drilled footage (ft)	90.5	90.4
Approximate length of 2-in. or 3-in. ID permanent casing and screen[a] (ft)	199	190
Screened interval (ft bgs)	167-197	158-188

[a] Actual final casing and screen placement will be determined after the evaluation of conditions observed during drilling. Assumes 0.6-m (2-ft) blank casing and cap below screen.

bgs = below ground surface

Table 2-2. Well Construction Materials.

Feature	Material	Size
Temporary casing	Carbon steel	6-in. ID (flush thread or welded)
Final casing	Stainless steel	2-in. or 3-in. ID (flush thread)
Screen	Stainless steel, vee-wire-wrapped	2-in. or 3-in. ID (flush thread) 0.020 slot
Annular seal	Cement grout with 5% bentonite	NA
Filter pack	Silica sand	10-20

NA = not applicable

3.0 DATA QUALITY OBJECTIVES FOR SAMPLING AND ANALYSIS

The DQO development process was used to (1) identify data needs, (2) specify sampling and analysis requirements for characterization of subsurface soil at the site, and (3) designate wastes. A DQO summary report was prepared and is included in this document as Appendix C. The DQOs for the specific sampling and analysis activities for the well-deepening activity are discussed in the following sections.

3.1 VADOSE ZONE SOIL CHARACTERIZATION DATA QUALITY OBJECTIVES

The DQOs for vadose zone characterization and waste designation during the well-deepening activity are driven by the desire to collect additional information regarding the site-related contaminants located above, within, and beneath the Plio-Pleistocene unit at this site. The contaminants shown in Table 3-1 have been identified as potential contaminants of concern (COCs) for this site based on historic release information and waste management requirements. The DQO process identified the need for relatively intensive sampling across the Plio-Pleistocene unit with less intense sampling in the vadose zone beneath the Plio-Pleistocene unit, and measurement of VOCs in soil vapor at discrete levels across the drilled interval. These objectives will be achieved by collecting split-spoon soil samples at selected intervals for laboratory analysis and by collecting soil vapor samples from the borehole(s) at discrete levels using an inflatable packer and air pump. The VOC concentration in soil vapor samples will be determined in the field using screening instruments.

The sampling design is judgmental and focused on identifying the vertical distribution of contaminants across the Plio-Pleistocene unit and underlying material to the planned depth of the borings.

3.2 WASTE DESIGNATION DATA QUALITY OBJECTIVES

Based on historical sampling and analysis of vadose zone soil from nearby wells, a specific list of potential COCs for waste designation was developed. The COCs for waste disposal during this activity include VOCs, semi-volatile organic compounds, toxic metals, and radionuclides. Specific COCs for waste designation following the well-deepening activity were identified in the DQO summary report (Appendix C). The COCs and their respective waste acceptance criteria are shown in Table 3-1.

Drill-cutting waste (i.e., soil cuttings) is considered to be "F001" listed waste based on the *Waste Management Plan for the Expedited Response Action for 200 West Area Carbon Tetrachloride Plume and the 200-ZP-1 Operable Unit* (DOE-RL 2000). The cuttings will also be designated based on the results of analysis of soil samples collected for subsurface characterization. The measured concentration of COCs will be compared to the waste acceptance criteria established for the Environmental Restoration Disposal Facility (ERDF) (BHI 1998). Liquid wastes (e.g., decontamination fluids) will be sampled and analyzed for COCs, and the results will be used for waste designation. If contaminant concentrations are below the ERDF waste acceptance criteria, the waste will be disposed at the ERDF. If the waste materials do not meet the ERDF waste acceptance criteria and are not therefore suitable for disposal at ERDF, and alternative disposal mechanism will be identified and approved by the regulatory agencies prior to disposal of the waste. The likely alternative to ERDF disposal is transferring the waste to the Hanford Site's Central Waste Complex.

Table 3-1. Contaminants of Concern and ERDF Waste Acceptance Criteria.

Contaminant Category	Contaminant of Concern	ERDF Waste Acceptance Criterion
Volatile organic compounds	Cis-1,2-dichloroethylene	30 mg/kg
	Trans-1,2-dichloroethylene	30 mg/kg
	1,1-Dichloroethane	6 mg/kg
	1,2-Dichloroethane	6 mg/kg
	1,1,1-Trichloroethane	6 mg/kg
	Acetone	160 mg/kg
	Benzene	10 mg/kg
	Carbon tetrachloride	6 mg/kg
	Chloroform	6 mg/kg
	Chlorobenzene	6 mg/kg
	Ethylbenzene	10 mg/kg
	Methylene chloride	30 mg/kg
	Methyl isobutyl ketone	33 mg/kg
	Tetrachloroethylene	6 mg/kg
	Trichloroethylene	6 mg/kg
	o-, m-, p-Xylene	30 mg/kg
Semi-volatile organic compounds	Phenol	6.2 mg/kg
	Tributyl phosphate	10,000 mg/kg
	Lard oil	Not regulated
Metals (nonradioactive)	Arsenic	100 mg/kg
	Barium	2,000 mg/kg
	Cadmium	20 mg/kg
	Chromium	100 mg/kg
	Lead	100 mg/kg
	Mercury	4 mg/kg
	Selenium	100 mg/kg
	Silver	100 mg/kg
	Beryllium	24.4 mg/kg
	Nickel	220 mg/kg
	Antimony	23 mg/kg
	Vanadium	32 mg/kg
	Zinc	86 mg/kg
Radioisotopes	Total alpha	Screen against two times Hanford Site general background
	Total beta/gamma	Screen against two times Hanford Site general background
	Amercium-241	1.56 E+3 pCi/g[a]
	Antimony-125	1.92 E+3 pCi/g[a]
	Cobalt-60	3.81 E+6 pCi/g[a]
	Cesium-137	2.67 E+7 pCi/g[a]
	Plutonium-238	1.00 E+3 pCi/g[a]
	Plutonium-239/240	6.22 E+3 pCi/g[a]
	Plutonium-241	6.06 E+4 pCi/g[a]
	Strontium-90	3.70E+9 pCi/g
	Neptunium-237	7.65E+2 pCi/g

[a]Values derived from ERDF concentration limits specified in Table 3 of *Environmental Restoration Disposal Facility Waste Acceptance Criteria* (BHI 1998), using 1.96 g/cm^3 for soil bulk density.

4.0 SAMPLING AND ANALYSIS IN SUPPORT OF WELL MODIFICATIONS

Sampling and analysis activities conducted during the well-deepening effort will focus on developing supplemental information regarding the nature and extent of vadose zone contamination in the vicinity of the Z-9 Trench. These sampling activities are discussed in the following sections. Additional subsurface soil samples will be collected to support other projects, including samples to be used for biodegradation studies by Pacific Northwest National Laboratory (PNNL). Other than waste determination, the subsequent analysis or testing of these samples is not covered by the well-deepening project. Any sampling activities not identified in this document must be funded separately by the requesting project.

Project planning personnel for this project met with staff working on the 200 Area assessment planning during preparation of the DQO and development of this document. The two actions are complementary in that the planned 200-PW-1 sampling and analysis effort is focused on the volume of soil directly underlying the trench, while the information to be collected during this characterization effort will provide useful information to the 200-PW-1 project with respect to expected conditions atop, within, and beneath the Plio-Pleistocene unit, as well as information regarding the topography of the top of the Plio-Pleistocene unit.

Additional details of the sampling activities are described in the following subsections. A summary of the samples to be collected during the well-deepening activity is presented in Table 4-1. An SAI will be prepared to support this activity.

4.1 VADOSE ZONE SAMPLING

Vadose zone characterization will consist of collecting and analyzing subsurface soil samples at selected intervals and measuring soil vapor samples from selected elevations during drilling. The Plio-Pleistocene unit forms a substantial restricting layer to vertical migration of liquids and dissolved/suspended contaminants at the Z-9 Trench. The Plio-Pleistocene unit and the soil immediately overlying it are expected to exhibit elevated contaminant concentration. The strategy for sampling soil and soil vapor during the well-deepening activity is a follows:

- Collect soil vapor samples at these selected elevations: (1) in the Hanford formation immediately above the Plio-Pleistocene, (2) midway through the Plio-Pleistocene, and (3) immediately beneath the Plio-Pleistocene unit. Soil vapor samples will then be collected at approximately 6-m (20-ft) intervals to the bottom of the boring. The soil vapor samples will be analyzed in the field for VOCs only.

- Collect continuous split-spoon soil samples from the elevation immediately overlying the Plio-Pleistocene unit through the full thickness of the Plio-Pleistocene unit (approximately 12 split-spoon samples, distributed as specified in Table 4-1). These soil samples will be submitted for laboratory analysis of the COCs identified in Table 3-1.

- Collect split-spoon soil samples from the Ringold Formation at 3.0-m (10-ft) intervals from the bottom of the Plio-Pleistocene unit to the bottom of the planned screened interval (approximately seven split-spoon samples, distributed as specified in Table 4-1). These soil samples will be submitted for laboratory analysis of the COCs identified in Table 3-1.

The sampling approach will provide a thorough description of contaminant conditions across the vertical extent of the borings. The methods used to collect soil and soil vapor samples are described in the following subsections.

4.1.1 Soil Vapor Sampling Method

The following procedural steps will be used to collect soil vapor samples during well deepening:

1. Advance the borehole to approximately 0.3 m (2 ft) beyond the bottom of the temporary casing.

2. Remove the drilling tool(s) from the borehole.

3. Insert a commercial inflatable rubber packer or test plug with the vapor sampling tube attached. Insert the packer/test plug to a depth within the casing, near the bottom end of the temporary casing.

4. Inflate the packer/test plug to seal off the casing and leave the end of the sampling tube exposed to the soil vapor in or near the open portion of the borehole.

5. Use an air sampling pump to withdraw vapor from the vapor sampling tube into a tedlar bag.

6. Measure the gross VOC concentration in the tedlar bag using a hand-held photoionization detector equipped with a minimum lamp voltage of 11.7 eV.

7. Measure the gross VOC concentration in the tedlar bag using a Bruel & Kjaer™ (a trademark of Bruel & Kjaer) gas monitor.

8. Record the measurements.

9. Deflate and remove the packer/test plug and continue drilling.

This approach will provide rapid quantification of the VOC concentration in the soil vapor at the site.

4.1.2 Soil Sampling Procedures

Soil samples will be collected during drilling using standard 4-in.-diameter by 24-in.-long split-spoon samplers fitted with four 6-in.-long stainless-steel liners. Split-spoon liners will be cleaned in accordance with *Waste Management Northwest Sampling Services Procedures Manual*, ES-SSPM-001, Procedure 2.5, "Laboratory Cleaning of Sampling Equipment."

Split-spoon samplers and other field sampling equipment used to collect the subsurface vadose zone samples will be decontaminated in accordance with procedure BHI-EE-01, *Environmental Investigations Procedures*, Procedure 6.2, "Field Cleaning and/or Decontamination of Geoprobe and Drilling Equipment."

One split-spoon sample in each boring from the continuous sampling through the Plio-Pleistocene unit will be collected specifically for use by PNNL staff for microbial population studies. These samples will be collected using a standard split-spoon sampler, and PNNL project staff will specially prepare the spoons and liners for these samples using aseptic techniques. PNNL staff will be present at the site to receive the collected samples and will provide handling and transport of the samples after collection. The split-spoon sample collected from the mid-point of the screened interval will also be transferred to PNNL for archiving to support potential future activities at the site (e.g., vadose zone tracer tests).

If sampler refusal is encountered during sample collection or incomplete sample recovery occurs at any specific sample interval, then the drill bit or core barrel (whichever is in use) will be advanced to the top of the next planned sample interval before additional sample collection is attempted.

4.2 WASTE CHARACTERIZATION SAMPLING AND ANALYSIS

Waste characterization sampling and analyses will be limited to liquid decontamination wastes generated during the drilling activity. Laboratory analytical data associated with split-spoon samples will be used to designate containerized suspect dangerous or mixed investigation-derived waste. The anticipated waste streams generated by this activity are described in Section 8.0 of this document. Waste will be managed in accordance with BHI-EE-10, *Waste Management Plan*. Approximately three to four 209-L (55-gal) drums of cuttings will be generated from each well that is deepened, resulting in a total of six to eight drums containing cuttings. In addition, approximately four drums of decontamination solutions will be generated. The DQOs developed for designation of well-deepening wastes are presented in Appendix C of this document and are summarized in Section 3.0.

One composite sample of liquid decontamination solutions will be collected after completion of the field activities. This sample will be analyzed for all COCs. Waste characterization samples are summarized in Table 4-1.

4.2.1 Accumulation of Drill Cuttings During Well-Deepening Activities

Drill cuttings will be placed directly into drums as they are removed from the well. Drums will be sealed immediately after filling and will be labeled with the contents (at a minimum, indicating the boring number and depth interval collected).

4.2.2 Accumulation of Decontamination Solutions

Field cleaning and decontamination of drilling equipment will be conducted in accordance with BHI-EE-01, Procedure 6.2. Decontamination solutions (consisting primarily of water) will be collected and transferred to United Nations-approved steel drums. The drums will be labeled as required by the site-specific waste management instruction (SSWMIs).

4.2.3 Waste Sampling Activities

One composite sample of the drummed decontamination solutions will be collected. The drummed rinsate from equipment decontamination will be composited into one sample for radiological and chemical analysis as specified in Table 3-1. A vertical profile of the rinsate in each drum will be collected using a peristaltic pump with Masterflex® (registered trademark of Cole-Parmer Instrument Company, Vernon Hills, Illinois) tubing or a composite liquid waste sampler (coliwassa).

All waste characterization samples (e.g., decontamination water) will be analyzed for the COCs specified in Section 3.0. Specific analytical methods and method performance requirements are shown in Appendix D of this document. Sampling activities will be conducted in accordance with BHI-QA-03, *ERC Quality Assurance Program Plans*, Plan No. 5.1, "Field Sampling Quality Assurance Program Plan."

Collection and transportation of samples will be in accordance with BHI-EE-01 procedures. The sampler's logbook will document the drum numbers and the depth of intervals associated with samples collected from each borehole. Field duplicate and blank samples will not be collected. Any deviations from this document will be documented in the sampler's logbook.

Sample containers and preservatives (if required) will be identified on the sample authorization form. The following BHI-EE-01 procedures will be used during sample collection and transportation:

- Procedure 1.5, "Field Logbooks"
- Procedure 2.0, "Sample Event Coordination"
- Procedure 3.0, "Chain of Custody"
- Procedure 3.1, "Sample Packaging and Shipping"
- Procedure 3.2, "Field Decontamination of Sampling Equipment"
- Procedure 4.0, "Soil and Sediment Sampling"
- Procedure 4.2, "Sample Storage and Shipping Facility"
- Procedure 4.4, "Container Sampling"
- Procedure 4.5, "Sample Compositing."

Table 4-1. Sample Summary for the Well-Deepening Activity.

Sample Type	Sample Use	Sample Location	Sampling Method	Number of Samples
Soil core	Characterization	Continuous through Plio-Pleistocene unit	Split-spoon sampler with stainless-steel liners	11 per well
Soil core	PNNL microbial studies	Within Plio-Pleistocene unit	Split-spoon sampler with aseptically prepared liners	1 per well
Soil core	Characterization	Sample at 3-m (10-ft) intervals from bottom of Plio-Pleistocene unit to top of screened interval	Split-spoon sampler with stainless-steel liners	4 per well
Soil core	Characterization	Sample at top and bottom of screened interval	Split-spoon sampler with stainless-steel liners	2 per well
Soil core	PNNL archive for future tracer studies	Midpoint of screened interval	Split-spoon sampler with stainless-steel liners	1 per well
Soil vapor	Characterization	One location each above, within, and beneath the Plio-Pleistocene unit, then at approximately 6-m (20-ft) intervals to the bottom of the hole	Inflatable packer/air pump, tedlar bag, direct reading photoionization detector, and Bruel &Kjaer instrument	5 per well
Decontamination solutions	Radiological and nonradiological waste designation	From drummed fluids	Composite with coliwassa or peristaltic pump	One sample total

5.0 GENERAL REQUIREMENTS

Field work for the well-deepening activity will be conducted in accordance with existing ERC procedures and protocols and the specifications in this document. The applicable ERC procedures are discussed in the following sections.

5.1 APPLICABLE PROCEDURES

Applicable ERC procedures for this activity are found in BHI-EE-01, including the following procedures:

- Procedure 1.2, "Data Quality Objectives"
- Procedure 1.5, "Field Logbooks"
- Procedure 2.0, "Sample Event Coordination"
- Procedure 3.0, "Chain of Custody"
- Procedure 3.1, "Sample Packaging and Shipment"
- Procedure 3.2, "Field Decontamination of Sampling Equipment"
- Procedure 4.0, "Soil and Sediment Sampling"
- Procedure 4.4, "Container Sampling"
- Procedure 4.5, "Sample Compositing"
- Procedure 6.2, "Field Cleaning and/or Decontamination of Geoprobe and Drilling Equipment"
- Procedure 7.0, "Geologic Logging."

Also applicable to this activity is BHI-EE-02, *Environmental Requirements*, Section 14.0, "Drilling, Maintaining, Remediating, and Decommissioning Resource Protection Wells, Geoprobe and Geotechnical Soil Borings." Additional procedures applicable to field operations are found in BHI-FS-01, *Field Support Administration*, Procedure 7.1, "Field Support Training."

5.2 HEALTH AND SAFETY

Field operations will be conducted in accordance with a site-specific health and safety plan or job hazard analysis prepared and implemented in accordance with ERC procedures. Information regarding the subsurface contamination status of the Z-9 Trench and vicinity is presented in the following subsections.

5.2.1 216-Z-9 Trench Disposal History

The Z-9 Trench received a variety of liquid waste streams from PFP plutonium recovery operations. These waste streams included the following:

- Acidic, high-salt, low-level radioactive aqueous process wastes
- Organic-rich radioactive liquid wastes containing carbon tetrachloride, mixed with tributyl phosphate and dibutyl butylphosphate, and containing intermediate concentrations of plutonium and other transuranic elements
- Carbon tetrachloride.

In 1976 and 1977, the trench floor was mined using remotely operated equipment to remove plutonium-contaminated soil from the trench. Approximately 58.1 kg (128 lb) of plutonium was recovered during the mining operation. An estimated 38 to 48 kg (84 to 106 lb) of plutonium remains in the soil beneath the crib. In at least one instance (i.e., at well 299-W15-8), radiological contamination was observed at a depth of approximately 30 m (100 ft) below ground surface. This observation suggests that in some locations near the Z-9 Trench, radiological contaminants have migrated downward at least to the depth of the Plio-Pleistocene unit. Carbon tetrachloride contamination extends to the groundwater beneath the trench.

5.2.2 Subsurface Contamination Conditions Observed in Surrounding Wells

Well logs and observations recorded during drilling near the Z-9 Trench were reviewed to identify potential contamination concerns associated with the site. No wells have been drilled near the trench since 1995, and subsurface conditions may have changed substantially due to the SVE operation. The following observations in vadose wells were obtained from the Hanford Well Information System and are considered relevant to safety concerns during the proposed well-deepening activity. See Figure 2-1 for well locations relative to the Z-9 Trench.

- Well 299-W15-8 exhibited VOCs in the borehole, and casing perforation tools used at the elevation of the Plio-Pleistocene unit were contaminated with alpha-, beta-, and gamma-emitting radionuclides when removed from the borehole in 1995.
- Well 299-W15-216 exhibited VOCs in the borehole, and approximately 3 m (10 ft) of perched water were encountered atop the Plio-Pleistocene unit in 1992.

- Well 299-W15-86 exhibited 1.5 m (5 ft) of water present in the well in 1995.
- Well 299-W15-220 exhibited VOCs in the boring and approximately 3 m (10 ft) of perched water on top of the Plio-Pleistocene unit in 1993.
- Well 299-W15-217 exhibited VOCs in the vadose zone from 8 m (25 ft) below surface to the Plio-Pleistocene unit in 1992.
- Well 299-W15-32 exhibited VOCs in the vadose zone and elevated temperatures in 1995. The Plio-Pleistocene unit was moist at that time.
- Well 299-W15-6 exhibited VOCs in the vadose zone.
- Well 299-W15-218 exhibited several moist horizons through the vadose zone above the Plio-Pleistocene unit, which was also moist in 1993.
- Well 299-W15-223 exhibited VOCs in the vadose zone and moist soil from a depth of approximately 15 m (50 ft) below surface to the Plio-Pleistocene unit in 1993.

The preceding observations of subsurface contamination conditions in the vicinity of the Z-9 Trench indicate that particular awareness must be maintained for the following conditions:

- Potential high concentrations of VOCs, which can vent into the breathing zone during drilling
- Potential presence of alpha-emitting radionuclides
- Potential perched water above the Plio-Pleistocene unit.

5.3 AIR MONITORING

No air monitoring for air pollutants will be conducted during this well-deepening activity other than as required for industrial hygiene and worker radiation protection. The drilling activities for this project will be conducted in accordance with the Environmental Restoration Program As Low As Reasonably Achievable Control Technology Demonstration for Drilling. This agreement with the Washington Department of Health addresses the radioactive air emission control requirements to be implemented during drilling activities.

6.0 QUALITY ASSURANCE

Sampling and analysis activities will be conducted in accordance with BHI-QA-03, Plan No. 5.1, "Field Sampling Quality Assurance Program Plan." An SAI will be prepared for the characterization and waste designation samples. The SAI will address detailed quality assurance requirements. The project documents, measurement data, and work products generated during the well-deepening activities will undergo review and verification in accordance with existing ERC procedures and practices. The applicable procedures are discussed in the following sections.

6.1 FIELD MEASUREMENT REQUIREMENTS

All radiological and industrial hygiene surveys will be performed in accordance with established ERC procedures and in a manner that is consistent with the site-specific health and safety plan. Field screening analyses will include radiation protection and industrial hygiene surveys using hand-held portable instruments. A portable photoionization detector will be used to measure VOCs in soil vapor samples. All field instruments will be calibrated and operated in accordance with the manufacturer's instructions.

6.2 LABORATORY ANALYSIS REQUIREMENTS

Laboratory analyses will be required for waste characterization samples. The specific analyses required for waste designation were developed during the DQO process and are as follows:

- VOCs (EPA Method 8260 [EPA 1986])
- Semi-volatile organic compounds (including tributyl phosphate) (EPA Method 8270 [EPA 1986])
- Total metals by inductively coupled plasma (EPA Method 6010 [EPA 1986])
- Gross alpha activity (by alpha scintillation)
- Gross beta activity (by gas proportional counting)
- Cobalt-60 and cesium-137 (by gamma spectroscopy)
- Plutonium-238, plutonium-239/240, and plutonium-241 (by alpha spectroscopy)
- Oil and grease by solvent extraction and gravimetric determination (EPA Method 413.2 [EPA 1983]).

Complete analyte lists and analytical laboratory analytical performance requirements are presented in Appendix D.

The samples will be shipped to an offsite subcontract laboratory in most cases. If radiological contamination exceeds laboratory acceptance criteria, the samples will be analyzed by a qualified onsite laboratory.

Data validation will not be performed for waste characterization analyses. The waste characterization data packages will, however, receive administrative and technical verification in accordance with BHI-EE-01, Procedure 2.3, "Data Package Administrative Verification," and Procedure 2.4, "Data Package Technical Verification." Data verification will be completed prior to using the data for waste designation. Field quality assurance/quality control samples (e.g., duplicates, splits, or blanks) will not be collected for this field activity.

7.0 PROJECT DOCUMENTATION

Documentation requirements for these activities are separated into scoping documents, field activity documents, and reporting documents. The following documents will be prepared to support the well-deepening activity:

- Scoping documents
  - This document
  - DQO summary report (see Appendix C)
  - Waste management plan (DOE-RL 2000)
  - SSWMI
  - Drilling specifications/subcontractor scope of work (procurement package)
  - SAI
- Field documentation
  - Field activity daily logs
  - Sample collection, custody, and shipment documentation
  - Well logs (lithologic and completion)
  - Field logbook
- Reporting documents
  - Well completion report, which will include the results of sampling and analysis for characterization and waste designation.

The documents/records produced for this project will receive technical and management review in accordance with ERC practices and procedures. The required reviewers will be identified prior to document completion, and the review time will be established as soon as practical.

8.0 WASTE MANAGEMENT

The well-deepening activities will generate solid waste. Waste generated during drilling activities at the Z-9 Trench is covered by an existing waste management plan (DOE-RL 2000), and waste will be managed in accordance with BHI-EE-10. The anticipated waste streams and the general management requirements are discussed in the following sections.

A SSWMI is in place that covers this type of work at this location. The SSWMI specifies the physical and administrative requirements for waste collection, containerization, storage, labeling, and handling. Field activities that generate waste streams will be conducted in accordance with the SSWMI.

Investigation-derived wastes will be managed in accordance with operable unit waste management procedures and in a manner that is consistent with the waste management plan for management of investigation-derived wastes such as the drill cuttings and decontamination solutions to be generated during characterization activities. The containerized wastes will be transferred from the drill site(s) to the operable unit centralized container storage area in accordance with the SSWMI.

8.1 WASTE STREAMS GENERATED DURING FIELD OPERATIONS

The following waste streams will be generated during field operations to deepen existing wells:

- Drill cuttings
- Used personal protective equipment (PPE)
- Decontamination solutions
- Contamination-control materials
- Noncontaminated solid wastes.

The drill cuttings, decontamination solutions, contaminated PPE, and contaminated plastic sheeting and other material are assumed to be listed waste for content of carbon tetrachloride. These waste streams will be immediately containerized as investigation-derived waste and managed in accordance with BHI-EE-10. The results of the split-spoon soil sample analysis will be used to designate the containerized soil cuttings. The Analytical Field Services group will sample the investigation-derived decontamination solutions after all decontamination has been performed and will submit the samples for analysis. Laboratory waste or unused samples will not be returned. Analytical laboratory waste will be disposed by the laboratory in accordance with the laboratory contract and all state and federal requirements.

8.2 WASTE SAMPLING REQUIREMENTS

The sampling and analysis requirements for drill cuttings and decontamination solutions are described in Section 4.0 of this document. Drill cuttings will not be sampled and analyzed; the drill cuttings will be designated based on the results of characterization samples collected during drilling. Decontamination solutions will be sampled and analyzed for the contaminants in Table 3-1 prior to disposal to ensure that the correct waste designation is made.

Used PPE and contamination-control materials will not be sampled, but will be evaluated for waste designation based on the results of analyses of the soil samples and decontamination solutions.

Noncontaminated solid waste will be segregated from potentially contaminated material and will not be sampled.

8.3 WASTE CONTAINER AND LABELING REQUIREMENTS

All drill cuttings and decontamination solutions generated during the well-deepening activities will be placed directly into United Nations standard steel drums. These drums will be stored, labeled, and managed in accordance with the requirements of the waste management plan, the SSWMI, and BHI-EE-10, *Waste Management Plan*. Labels will include information regarding the specific well and the approximate depth interval from which the drill cuttings were generated. Waste drums will be kept closed except when materials are added or samples are collected.

8.4 WASTE DISPOSAL ARRANGEMENTS

Project staff anticipate that the waste generated by the well-deepening activities will be disposed at the ERDF. If the waste materials do not meet the ERDF waste acceptance criteria and are not, therefore, suitable for disposal at ERDF, an alternative disposal mechanism will be identified and approved by the regulatory agencies prior to disposal of the waste. The likely alternative to ERDF disposal is transferring the waste to the Hanford Site's Central Waste Complex.

9.0 SCHEDULE

The well-deepening and reconfiguration activity is anticipated to take place in the spring of 2001.

10.0 REFERENCES

BHI, 1998, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*, BHI-00139, Rev. 3, Bechtel Hanford, Inc., Richland, Washington.

BHI-EE-01, *Environmental Investigations Procedures*, Bechtel Hanford, Inc., Richland, Washington.

BHI-EE-02, *Environmental Requirements*, Bechtel Hanford, Inc., Richland, Washington.

BHI-EE-10, *Waste Management Plan*, Bechtel Hanford, Inc., Richland, Washington.

BHI-FS-01, *Field Support Administration*, Bechtel Hanford, Inc., Richland, Washington.

BHI-QA-03, *ERC Quality Assurance Program Plans*, Bechtel Hanford, Inc., Richland, Washington.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 U.S.C. 9601, et seq.

DOE-RL, 2000, *Waste Management Plan for the Expedited Response Action for 200 West Area Carbon Tetrachloride Plume and the 200-ZP-1 Operable Unit*, DOE/RL-2000-40, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

EPA, 1983, *Methods for Chemical Analysis of Water and Wastes*, EPA 600/4-79-020, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1986, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*, 3rd edition, as amended, SW-8416, U.S. Environmental Protection Agency, Washington, D.C.

Rohay, V. J., 1994, *1994 Conceptual Model of the Carbon Tetrachloride Contamination in the 200 West Area at the Hanford Site*, WHC-SD-EN-TI-248, Rev. 0., Westinghouse Hanford Company, Richland, Washington.

Rohay, V. J., 2000, *Performance Evaluation Report for Soil Vapor Extraction Operations at the Carbon Tetrachloride Site, February 1992 – September 1999*, BHI-00720, Rev. 4, Bechtel Hanford, Inc., Richland, Washington.

Rohay, V. J. and W. J. McMahon, 1996, *Airflow Modeling Report for Vapor Extraction Operations at the 200-ZP-2 Operable Unit (Carbon Tetrachloride Expedited Response Action)*, BHI-00882, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

WAC 173-160, "Minimum Standard for Construction and Maintenance of Wells," Part Two, "General Requirements for Resource Protection Wells," *Washington Administrative Code*, as amended.

Waste Management Northwest Sampling Services Procedures Manual, ES-SSPM-001, Waste Management Northwest, Richland, Washington.

APPENDIX A

WELL DATA SHEETS
(CURRENT CONFIGURATION)

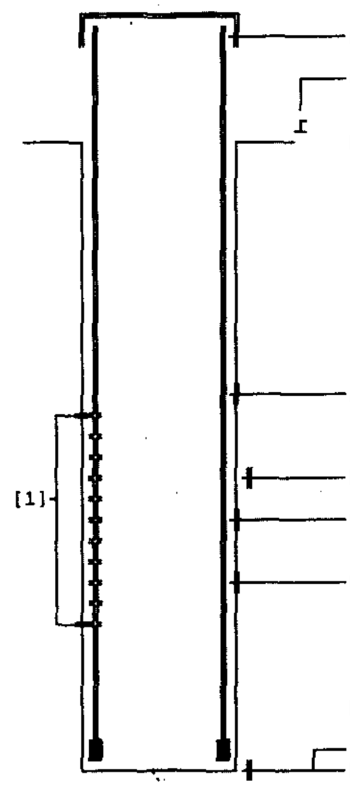
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Hard tool (nom)	WELL NUMBER: 299-W15-84 TEMPORARY WELL NO: 2904 #3
Drilling Fluid Used: Water	Additives Used: Not documented	Hanford Coordinates: N/S N 39,860 E/W W 76,000
Driller's Name: Row/Jahnke	WA State Lic Nr: Not documented	State Coordinates: N 444,967 E 2,219,223
Drilling Company: Not documented	Company Location: ND	Start Card #: Not documented T___ R___ S___
Date Started: 06Oct54	Date Complete: 10Oct54	Elevation Ground surface (ft): Not documented

Depth to water: Not applicable

DIAGRAMMATIC BOREHOLE
REMEDIATION PLAN
(Depths are from ground surface)

[1] Perforate 8-in casing,
75-90-ft, 4 cuts/ft/rd.



Elevation of reference point: (top of casing)	[669.82-ft]
Height of reference point above ground surface	[ND]
Depth of surface seal	[ND]
Type of surface seal: None documented	
I.D. of surface casing (If present)	[ND]
I.D. of riser pipe:	[8-in]
Type of riser pipe: Carbon steel	
Diameter of borehole:	[9-in nom]
Type of filler: Not documented	
Elevation/depth top of seal	
Type of seal: Not documented	
No perforations documented:	
Depth bottom of casing	[110-ft]
Depth bottom of borehole:	[110-ft]

Drawing By: RKL/2W15-84.PLN   Date: 30Mar93

Reference: HANFORD WELLS

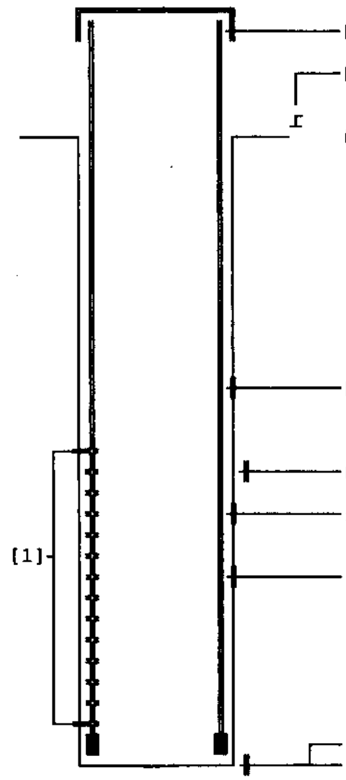
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Hard tool (nom)	WELL NUMBER: 299-W15-95	TEMPORARY WELL NO:
Drilling Fluid Used: Not documented	Additives Used: Not documented	Hanford Coordinates: N/S N 39,930	E/W W 75,925
Driller's Name: Osburn	WA State Lic Nr: Not documented	State Coordinates: N 445,037	E 2,219,298
Drilling Company: Not documented	Company Location: ND	Start Card #: Not documented	T R S
Date Started: 19Jan59	Date Complete: 21Jan59	Elevation Ground surface (ft): Not documented	

Depth to water: Not applicable

DIAGRAMMATIC BOREHOLE
REMEDIATION PLAN
(Depths are from ground surface)

[1] Perforate 8-in casing,
83-98-ft, 4 cuts/rd/ft.



Elevation of reference point: (top of casing) [660.00-ft]

Height of reference point above ground surface [ND]

Depth of surface seal [ND]

Type of surface seal:
None documented

I.D. of surface casing (If present) [ND]

I.D. of riser pipe: [8-in]
Type of riser pipe:
Carbon steel

Diameter of borehole: [9-in nom]

Type of filler:
Not documented

Elevation/depth top of seal
Type of seal: Not documented

No perforations documented:

Depth bottom of casing
Depth bottom of borehole: [100-ft]

Drawing By: RKL/2W15-95.PLN Date: 30Mar93

Reference: HANFORD WELLS

APPENDIX B

WELL CONSTRUCTION VARIANCE

VARIANCE REQUEST

The upcoming Partitioning Interwell Tracer Test (PITT) requires that 3 existing wells be deepened by approximately 110 feet. The 3 well proposed for this activity are 299-W15-84, 299-W15-95, and 299-W15-82. These wells were drilled in 1954, 1959, and 1954 respectively and do not meet WAC 173-160 requirements. They were drill via cable tool method using 8-5/8" carbon steel casing and were not sealed.

Our proposal for deepening these wells is to drill out from under the existing 8-5/8" with 6-5/8" or 6-1/2" casing to the top of groundwater (approximately 220 ft below ground surface) and complete the wells below the existing casing as 3" diameter 10 to 15 ft above the water table.

A. Name, address, and phone number of person requesting variance:
John Auten; 3190 George Washington Way, Richland Wa. 99352; 372-9695

B. Address of the Well site:
Hanford Site, Richland Washington

C. ¼, ¼ section, township, range:
SE ¼ of the SW ¼ Section 1 Township12N Range 25E

The specific regulations that cannot be followed; comparable alternative specifications; and justification for the request:

1. WAC 173-160-450

The 3" completions in a 6" diameter well bore does not meet the 2" annular space required by WAC 173-160 and thus requires a variance.

Thirty feet long wire wrap stainless steel screen will be paced at the bottom of each well, an appropriate filter pack installed across the screen interval, and the remainder of the hole below the 8-5/8" sealed with bentonite grout.

Well 299-W15-95 may be drilled below the water table for purposes of collecting a water sample. In such case the hole below the aquifer contact and extending 2 feet above the contact will be sealed using neat cement tremied to bottom.

Richard L Biggerstaff

Stan Leja Date ______
Stan Leja
WDOE Nuclear Waste Div.
Kennewick, Wa.

John Auten Date 9/1/00
John Auten
ERC Senior Drilling Engineer

APPENDIX C

DATA QUALITY OBJECTIVE SUMMARY REPORT

TABLE OF CONTENTS

Table of Contents

FIGURE

TABLES

ACRONYMS

AA	alternative action
COC	contaminant of concern
COPC	contaminant of potential concern
CRDL	contract-required detection limit
CWC	Central Waste Complex
DQO	data quality objective
DR	decision rule
DS	decision statement
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
NORM	naturally occurring radioactive material
PSQ	principal study question
SVE	soil vapor extraction
SVOC	semi-volatile organic compound
VOC	volatile organic compound
WAC	*Washington Administrative Code*
WS	waste stream

APPENDIX C

DATA QUALITY OBJECTIVE SUMMARY REPORT

C.1 STEP 1 – STATE THE PROBLEM

This data quality objective (DQO) summary report has been prepared in accordance with Environmental Restoration Contractor guidance. Project-specific issues are discussed in the following sections.

C.1.1 Project Objectives

The purpose of the well-deepening activity is to construct new soil vapor extraction screened intervals at lower elevations adjacent to the 216-Z-9 Trench (Z-9 Trench). The new screened intervals will be placed at the same elevation as other existing screened intervals in nearby wells to support expansion of the soil vapor extraction (SVE) system at the site. The purpose of this report is to define the DQOs to support supplemental sampling and analysis and waste designation decisions for the disposition of soil cuttings produced as waste during drilling to extend the depth of two existing vadose zone wells near the Z-9 Trench.

Because of the proximity of the two vadose zone boreholes to the Z-9 Trench, subsurface soil is assumed to be contaminated with chemical residues from historic disposals to the trench. Sampling and analysis will be conducted to provide supplemental site characterization during the well deepening activity. Because this is supplemental data collection and not related to cleanup decisions, the sampling will be conducted on a judgmental basis and samples will be analyzed for a suite of contaminants of concern (COCs) identified based on existing information.

Soil cuttings resulting from drilling operations are considered F001 listed waste as further discussed in *Waste Management Plan for the Expedited Response Action for 200 West Area Carbon Tetrachloride Plume and the 200-ZP-1 Operable Unit* (DOE-RL 2000). The cuttings and decontamination waste will be managed as investigation-derived waste in accordance with BHI-EE-10, *Waste Management Plan,* and will be disposed of at the Environmental Restoration Disposal Facility (ERDF) or at the Central Waste Complex if ERDF waste acceptance criteria are exceeded. Returning soil cuttings to the ground is not considered an alternative in this DQO.

The objectives of this DQO process are to (1) identify the COCs for characterization analyses, (2) describe a judgmental sampling approach, and (3) define waste characterization requirements to ensure that ERDF waste acceptance criteria will not be exceeded. The objective of DQO Step 1 is to use the information gathered from the DQO scoping process, as well as other relevant information, to clearly and concisely state the problem to be resolved.

The project assumptions, issues, and facility background are discussed in the following sections.

C.1.2 Project Assumptions

The project assumes that waste generated during this activity will be managed as listed dangerous waste (F001) in accordance with the *Waste Management Plan for the Expedited Response Action for 200 West Area Carbon Tetrachloride Plume and the 200-ZP-1 Operable Unit* (DOE-RL 2000) and will be disposed to the ERDF. Existing results from analyses of soil samples collected during the drilling of existing wells and borings in the vicinity of the Z-9 Trench are assumed to provide satisfactory definition of contaminants of potential concern (COPCs) for the current activity. The soil cuttings generated from these drilling operations will be containerized as they are generated due to anticipated elevated concentrations of carbon tetrachloride and other contaminants. The logic for waste disposition during this activity is shown in Figure C-1. Waste generated during this activity will not be evaluated for release to an offsite treatment, storage, and disposal unit. The waste disposition logic diagram assumes that the waste is listed waste and identifies decisions regarding the waste's status under the ERDF waste acceptance criteria. If the waste does not meet the ERDF acceptance criteria, alternative disposal pathways will be defined.

C.1.3 Project Issues

Issues relating to waste designation for the current planned activities are discussed in the following subsections.

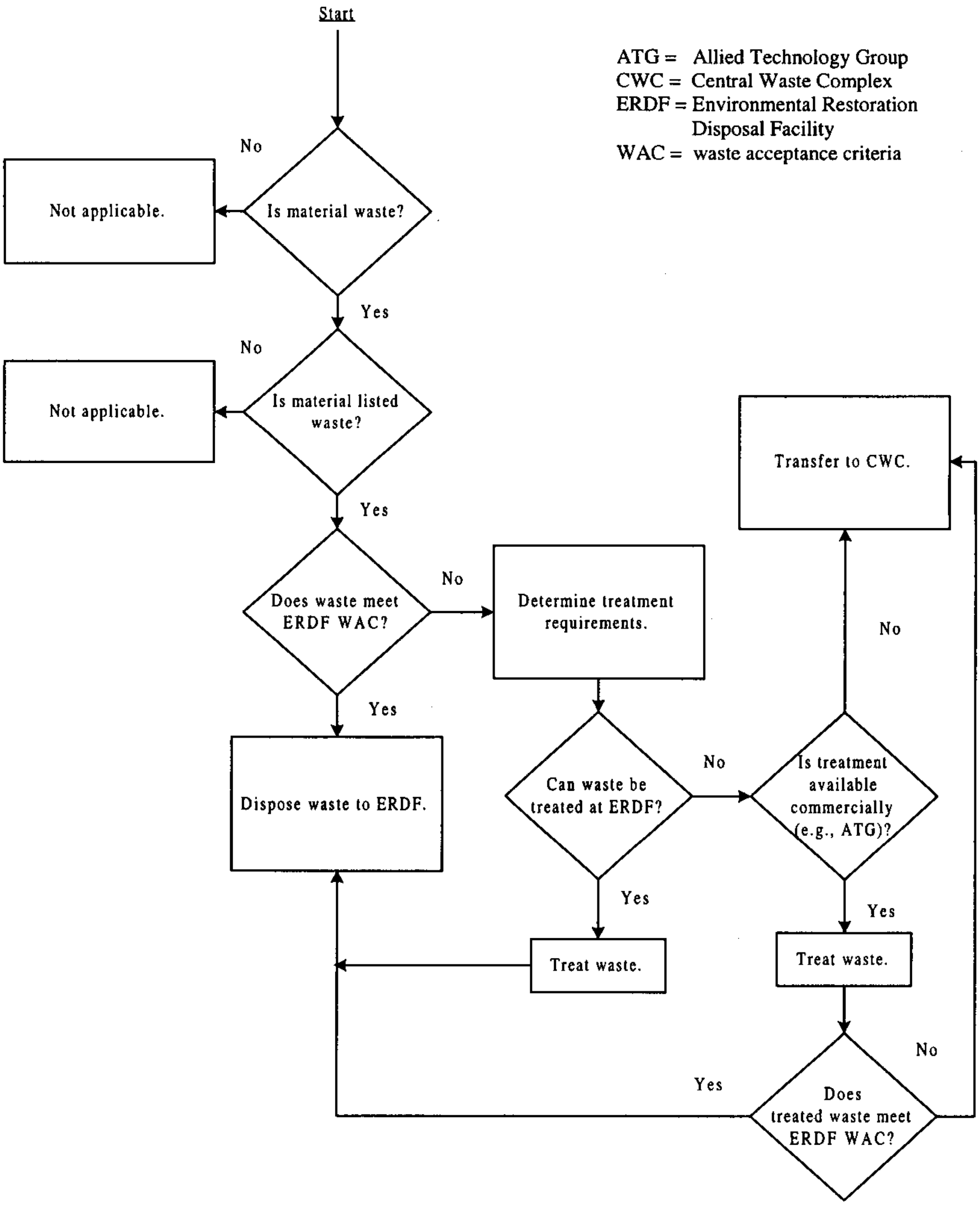
C.1.3.1 Global Issues. No global issues (i.e., issues that could not be resolved by the project decision makers) were identified for this project.

C.1.3.2 Project-Specific Technical Issues and Resolutions. The well-deepening project was first conceived to support a vadose zone tracer test to attempt to quantify residual phase-separated chlorinated solvent in the vadose zone. Characterization of the vadose zone soil would be performed by another contractor to support the tracer test. The planned vadose zone tracer test was subsequently postponed; the well deepening will be performed to enhance the existing soil vapor extraction system at the site. This presented the opportunity to incorporate characterization sampling and analysis into the well-deepening scope. During review of the draft description of work, the U.S. Environmental Protection Agency (EPA) project manager identified several recommended characterization approaches that would provide useful information if implemented during drilling for the deepened wells. All parties to the planning effort agreed that collection and analysis of subsurface soil samples and soil vapor samples during well deepening would add greatly to the knowledge base of contaminant nature and extent in the vicinity of the Z-9 Trench. The EPA manager also expressed interest in attempting to evaluate some of the lesser contaminants (e.g., lard oil) for which nonstandard methods must be used.

As a result of the EPA requests and the change in immediate scope for well deepening, the planned sampling and analysis of subsurface soils was changed to include characterization of soil within the drilled depth for COPCs and collection of subsurface soil vapor samples from discrete depths during drilling. The volatile organic compound (VOC) concentration in soil vapor samples will be determined using field instruments. Field instrument measurements will provide the necessary capability to identify changes in vapor concentrations with depth. A nonspecific analytical method (i.e., solvent extraction with subsequent gravimetric determination of oil and grease) will be used to attempt to quantify extractable non-VOCs such as lard oil, in addition to the standard analytical methods used to determine other contaminants.

The investigation-derived waste (i.e., drill cutting soil) will be characterized using the results of the characterization soil samples, and no sampling of the containerized soil cuttings will be performed. Containerized decontamination solutions will be sampled and analyzed for designation.

Figure C-1. Well-Deepening Activity Waste Disposition Logic.



C.1.4 Facility Background Information

The well-deepening activity will be conducted in two existing wells adjacent to the Z-9 Trench. The Z-9 Trench is one of three disposal facilities that received large volumes of nonaqueous liquid wastes generated during plutonium processing and reclamation at the Plutonium Finishing Plant. The facility history is summarized in the following subsections.

C.1.4.1 Process History. The Plutonium Finishing Plant processed plutonium-bearing acid solutions to produce purified plutonium metal. This process operated from 1949 to the mid-1980s. Liquid wastes generated in the processing of plutonium solutions were disposed either to the ground or to a series of underground storage tanks, depending on the nature of the waste streams. Liquid wastes included acidic aqueous wastes and nonaqueous wastes (e.g., spent chlorinated solvents).

C.1.4.2 Study Area. This DQO process focuses on the characterization of soil within the vadose zone and proper designation of investigation-derived wastes (principally drill-cutting soil) that will be generated during well-deepening operations at two existing vadose zone wells immediately surrounding the Z-9 Trench. This area falls within the boundaries of the 200-ZP-1 Groundwater Operable Unit and within the 200 West Area carbon tetrachloride expedited response action SVE area (200 ZP-2 Operable Unit). The specific wells considered under this project are wells 299-W15-84 and 299-W15-95. These wells will be deepened from their current depth of about 30.5 m (100 ft) below surface to approximately 61 m (200 ft) below ground surface. The wells will be reconfigured with screened intervals within the lower portion of the depth.

Approximately 1.8 m^3 (150 gal) of cuttings will be generated from each well for a total estimated volume of 3.6 m^3 (300 gal) of cuttings. The vadose zone and aquifer in this area are known to be contaminated with carbon tetrachloride.

C.1.4.3 Spill/Release History. The Z-9 Trench received aqueous and nonaqueous liquid wastes from the Recuplex process (a plutonium waste recovery process) from July 1955 to June 1962. Nonaqueous liquid wastes discharged to the Z-9 Trench included approximately 83,000 L to 300,000 L of carbon tetrachloride, 27,900 L of tributyl phosphate, 46,500 L of dibutyl butyl phosphonate, and approximately 9,300 L of lard oil. In addition to the nonaqueous liquids, large quantities of aqueous wastes (including acidic solutions and dilute solutions of the target nonaqueous liquids) were discharged to the Z-9 Trench.

C.1.4.4 General Housekeeping Practices. Liquid wastes were discharged below the ground surface. Housekeeping practices are not considered applicable for consideration in this DQO process.

C.1.4.5 Summary of Historical Data. Numerous monitoring wells and exploratory soil borings have been advanced in the vicinity of the Z-9 Trench. Table C-1 shows the maximum concentration of target organic and inorganic analytes detected in previous soil samples in wells and borings near the Z-9 Trench (WHC 1994).

Table C-1. Summary of Contaminants Detected in Soil Near the 216-Z-9 Trench and Reported Maximum Concentration.

Analyte	Maximum Concentration in Soil (µg/kg)	Well Number	Depth of Sample (m below surface)
Volatile Organic Compounds (detected in soil and groundwater)			
Methylene chloride	1,171	299-W15-220	30.6
Chloroform	730	299-W15-218	39.6
Carbon tetrachloride	37,817	299-W15-217	34.7
Trichloroethylene	13	299-W15-217	34.7
Tetrachloroethylene	28	299-W15-217	34.7
Cis-1,2 dichloroethylene	10	299-W15-218	39.6
1,1 dichloroethane	18	299-W15-217	34.7
1,2 dichloroethane	25	299-W15-218	24.4
1,1,1 trichloroethane	3	299-W15-217	34.7
Benzene	3	299-W15-217	16.5
Toluene	>1,329	299-W15-219	61.0
Ethylbenzene	4	299-W15-217	35.2
M+p-xylene	9	299-W15-217	35.2
o-Xylene	16	299-W15-218	59.4
n-Butyl benzene	2,000	299-W15-219	45.7
Chlorobenzene	70	299-W15-223	20.7
Semi-Volatile Organic Compounds			
Tributyl phosphate	62	299-W15-217	24.6
Phenol	220	299-W15-217	30.9
Toxicity Characteristic Metals			
Chromium	21,000	299-W15-217	24.6
Anions			
Chloride	54,000	299-W15-217	24.6
Fluoride	2,600	299-W15-217	37.1
Nitrate	1,600,000	299-W15-217	37.1
Sulfate	69,000	299-W15-217	37.1
Radionuclides (detected in soil and groundwater)			
Cobalt-60 (groundwater only)	2.19 pCi/L	299-W15-216	60.56
Ruthenium-106 (groundwater only)	29.5 pCi/L	299-W15-216	60.56
Antimony-125 (groundwater only)	6.84 pCi/L	299-W15-216	61.87
Cesium-137 (groundwater only)	3.47 pCi/L	299-W15-216	61.87
Lead-212	1.01 pCi/g	299-W15-217	35.3
Lead-214	1.73 pCi/g	299-W15-217	37.1
Radium-226	1.66 pCi/g	299-W15-217	37.1
Radium-224	1.01 pCi/g	299-W15-217	35.3
Gross alpha	11.1 pCi/g	299-W15-217	37.1
Gross beta	27.5 pCi/g	299-W15-217	16.6

C.1.5 Existing References

Table C-2 presents a list of references that were reviewed as part of the scoping process and a summary of the pertinent information contained within each reference.

Table C-2. Existing References. (2 Pages)

Reference	Summary
1994 Conceptual Model of the Carbon Tetrachloride Contamination in the 200 West Area at the Hanford Site, WHC-SD-EN-TI-248, Rev. 0 (WHC 1994)	Pages 4-28 through 4-36 present the analytical results from soil samples collected from six wells located in the vicinity of the 216-Z-9 Trench. The analyses that were performed include VOCs, semi-volatile organic compounds (SVOCs), metals, radionuclides, and anions. Analytical data were provided for the following: VOCs: methylene chloride, trans 1,2-DCE, 1,1-DCA, cis-1,2-DCE, chloroform, 1,1,1-TCA, carbon tetrachloride, 1,2-DCA, benzene, trichloroethylene, toluene, perchloroethene, ethylbenzene, M+P-xylene, O-xylene, acetone; n-butyl benzene SVOCs: o-creosol, m-creosol, p-creosol, decane, dodecane, tetradecane, napthalene, pentachlorophenol, phenol, tributyl phosphate Metals: Al, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Mg, Mn, Ni, K, Ag, Na, Sb, Sn, V, Zn Radionuclides: Cs-137, Co-60, Ru-106, Sb-125, Pb-212, Pb-214, Ra-224, Ra-226, Sr-90, Am-241, U-238, U-239/240
Waste Management Plan for the Expedited Response Action for 200 West Area Carbon Tetrachloride Plume and the 200-ZP-1 Operable Unit, DOE/RL-2000-40, Rev. 0 (DOE-RL 2000)	Groundwater associated with the 200-ZP-1 Operable Unit and soil vapor associated with the expedited response action contains carbon tetrachloride, which has been determined to be an "F001" listed waste at this site. Extracted groundwater, spent granular activated carbon, and other materials that come into contact with the groundwater and vapor will be assigned the "F001" listed waste code. Equipment/materials that are decontaminated will not be considered to contain a "F001" listed waste code. Other nonradiologically contaminated solid wastes designated as "F001" listed waste that are land disposal restricted due to greater than 10% organic carbonaceous waste will be disposed offsite to an appropriate facility. Other solid wastes (e.g., drill cuttings) that meet the ERDF waste acceptance criteria or that can be treated to meet the criteria will be disposed at the ERDF. Treatment is not required for waste that contains concentrations of carbon tetrachloride below 6 mg/kg. Nondangerous, uncontaminated soils and slurries will be placed on the ground near the point of generation. Soils and slurries that do not designate as dangerous waste, that are below *Model Toxics Control Act* soil cleanup standards (*Washington Administrative Code* [WAC] 173-340), and that have been released from a radiological perspective may be placed on the ground near the point of generation.
Refined Conceptual Model for the Volatile Organic Compounds -- Arid Integrated Demonstration and 200 West Area Carbon Tetrachloride Expedited Response Action, PNL-8597 (PNL 1993)	Refined conceptual site models show that the highest concentrations of carbon tetrachloride and chloroform are located just north of the 216-Z-9 Trench. The 216-Z-9 Trench is located 200 m due east of the Plutonium Finishing Plant. Chemicals used in process operations included nitric and hydrofluoric acids and carbon tetrachloride–tributyl phosphate solvent. Results from soil gas surveying performed in fiscal year 1992 identified the presence of carbon tetrachloride, chloroform, trichloroethylene, and tetrachloroethylene.

Table C-2. Existing References. (2 Pages)

Reference	Summary
Nuclear Reactivity Evaluations of 216-Z-9 Enclosed Trench, December 1973, ARH-2915 (Smith 1973)	This document summarizes chemical and radiological contamination within the 216-Z-9 Trench, including measurement of soil pH within the near-surface layers within the trench itself. The pH ranged from 3.6 in the upper 15.2 cm (6 in.) of the trench bottom to a pH of 4.1 at a depth of 2.4 m (8 ft).
Report on Plutonium Mining Activities at 216-Z-9 Enclosed Trench, RHO-ST-21 (Ludowise 1978)	The 216-Z-9 enclosed trench was completed in 1955 and was built for the disposal of both organic and aqueous plutonium waste solutions from the Recuplex Plutonium Scrap Recovery Facility in the 234-5 Z Plant. The 216-Z-9 enclosed trench is an underground excavation with an active floor area of 9.1 x 18.3 m at a mean sea level elevation of 195 m. The Recuplex process was a solvent extraction system that recovered plutonium from many types of scrap or wastes such as casting skulls, slag and crucible, button line supernates, and fabrication oil (a mixture of lard oil and 75% carbon tetrachloride). The Recuplex waste solutions consisted of aluminum, magnesium, calcium, and other metal nitrate salt wastes; degraded solvents (15% tributyl phosphate or dibutyl butyl phosphonate in carbon tetrachloride); other organics such as solvent washings; fabrication oil; and other waste materials from hood and equipment flushes.

C.1.6 Decision Identification

No decisions regarding contaminant status at the site will be made based on the supplemental characterization generated by the sampling and analysis of subsurface soil samples at this site. The site characterization data will provide greater insight into site conditions and will provide some information regarding conditions at the site following operation of the existing SVE system.

Decisions that will be made based on the data generated in this activity are related to designation of the waste generated during drilling activities. The COCs (based on existing site information) will be identified and their concentration relative to specific action limits for handling and disposal will be evaluated.

C.1.7 Contaminants of Potential Concern

Table C-3 identifies all of the COPCs associated with the site from which the waste material was derived.

C.1.8 Contaminant of Potential Concern Exclusions

Table C-4 presents a list of all COPCs to be excluded from the investigation. These exclusions are based on physical laws, process knowledge, task focus, and/or other mitigating factors. Table C-4 also provides the specific rational for the exclusion of each of the identified COPCs.

Table C-3. Contaminants of Potential Concern.

WS #	Description of Waste	Known or Suspected Means of Contamination of Waste	General Type of Contamination	Specific COPCs
1	Subsurface soil cuttings	Contamination was introduced to the 216-Z-9 Trench and surrounding soils through the disposition of an estimated 4,090,000 L of Recuplex current acid waste and aqueous and organic waste from the 234-5 Building	Radionuclides	Am-241, Cs-137, Co-60, Ru-106, Pb-212, Pb-214, Ra-224, Ra-226, Sb-125, Pu-238, Pu-239/240, Pu-241, Sr-90, Cs-137, Np-237
			VOCs	Trans 1,2-DCE, 1,1-DCA, cis-1,2-DCE, chloroform, 1,2-DCA, benzene, trichloroethylene, toluene, perchloroethene, ethylbenzene, chlorobenzene, M+P-xylene, o-xylene, n-butyl benzene, 2-butanone, 1,1,1-TCA, carbon tetrachloride, methylene chloride, acetone, methyl isobutyl ketone
			SVOCs	Decane, dodecane, tetradecane, napthalene, pentachlorophenol, phenol, tributyl phosphate, o-creosol, m-creosol, p-creosol
			Metals	Ag, Al, As, Ba, Be, Ca, Cd, Cr, Co, Cu, Fe, Hg, Mg, Mn, Ni, Pb, K, Sb, Sn, Se, Na, V, Zn
			Pesticides/herbicides	Chlordane, 2, 4-D, heptachlor and its epoxide, endrin, lindane, toxaphene, 2,4, 6-trichlorophenol, 2,4,5-TP
			Polychlorinated biphenyls	Polychlorinated biphenyls
			Characteristic waste (ignitability, corrosivity, reactivity, toxicity)	Metals, organic compounds, pH, sulfide, cyanide, flashpoint
			Characteristic waste (ignitability, corrosivity, reactivity, toxicity)	Metals, organic compounds, pH, sulfide, cyanide, flashpoint

WS = waste stream

Table C-4. Rationale for COPC Exclusion. (2 Pages)

COPC Excluded	Rationale for Exclusion
Ra-226	Naturally occurring radioactive material (NORM). Reported activity is consistent with decay of natural uranium. No elevated concentrations of this isotope were detected in the vicinity of the 216-Z-9 Trench (PNL 1993, p. E-13, 299-W15-216).
Ru-106	Short half-life of 1.02 years.
Sb-125	Short half-life of 2.76 years. Also has only 0.031% yield/fission versus 6.2% for Cs-137.
Pb-212	NORM. Reported activity is consistent with decay of natural uranium. Short half-life of 10.6 hours.
Pb-214	NORM. Reported activity is consistent with decay of natural uranium. Short half-life of 27 minutes.
Ra-224	NORM. Reported activity is consistent with decay of natural uranium. Short half-life of 3.7 days.

Table C-4. Rationale for COPC Exclusion. (2 Pages)

COPC Excluded	Rationale for Exclusion
VOCs: 2-butanone, n-butyl benzene	Excluded because they are not regulated by WAC 173-303.
Metals: Al, Ca, Co, Cu, Fe, K, Mg, Mn, Sn, Na	Excluded because they are not regulated by WAC 173-303 and are not found on the toxic characteristic leachate procedure list.
SVOCs: decane, dodecane, tetradecane	Excluded because they are not regulated by WAC 173-303.
SVOCs: napthalene, pentachlorophenol, o-creosol, m-creosol, and p-creosol	Excluded because they were not detected historically at the site (PNL 1993, pp. E-7 and E-8, 299-W15-216/299-W15-217).
Pesticides/herbicides	Historical documents provide no indication that pesticides or herbicides were used in the vicinity of the site. In addition, the drill cuttings represent a depth interval between 30.5 and 61 m (100 and 200 ft) and, therefore, have not been treated with these chemicals.
Polychlorinated biphenyls	Historical documents provide no indication that polychlorinated biphenyls were used or buried in the vicinity of the boreholes to be drilled.
Ignitability	The characteristic of ignitability is not applicable to soil cuttings.
Sulfide and cyanide	Cyanide was below detection limits from historical sampling performed in 299-W15-216 and 299-W15-217 (PNL 1993, pp. E-7 and E-8). Neither cyanide nor sulfide chemicals were used in the waste-generating processes.
Dibutyl-butylphosphonate and dibutyl phosphate	These compounds were excluded based on the lack of an applicable analytical method.
pH	pH measurements have historically been collected from the trench itself, which represents the worst-case scenario. Soil in the trench bottom exhibited pH consistently above 3.5 and increased with depth (Smith 1973). pH in the deep subsurface to be samples is expected to be near ambient conditions.

C.1.9 Final List of Contaminants of Concern

Table C-5 presents the final list of COCs that will be carried through the remainder of the DQO process.

Table C-5. Final List of COCs.

WS #	Specific COCs
1	Radionuclides: Am-241, Pu-238, Pu-239/Pu-240, Pu-241, Co-60, Cs-137, Sb-125, Sr-90, Np-237
	VOCs: trans 1,2-DCE, 1,1-DCA, cis-1,2-DCE, chloroform, carbon tetrachloride, 1,2-DCA, benzene, trichloroethylene, toluene, perchloroethene, ethylbenzene, M+P-xylene, o-xylene, 1,1,1-TCA, methylene chloride, chlorobenzene, acetone, methyl isobutyl ketone
	SVOCs: phenol, tributyl phosphate
	Misc.: lard oil
	Metals: Ag, As, Ba, Be, Cd, Cr, Hg, Ni, Pb, Sb, Se, V, Zn

C.1.10 Statement of the Problem

Soil and soil vapor samples will be collected during well-deepening activities to provide supplemental site characterization at the Z-9 Trench. The problem is to identify variations in contaminant concentrations in soil with increasing depth. There are limited data that describe the residual contamination above, within, and below the Plio-Pleistocene unit at the Z-9 Trench. Data are needed to support further site assessment, evaluate the performance of the SVE system, and evaluate the potential for presence of residual phase-separated organics in the vadose zone. A judgmental design will be used to identify sampling locations during drilling. Samples will be analyzed for the COCs identified above. The judgmental sampling design will focus on intensive sampling above, within, and immediately beneath the Plio-Pleistocene unit. This unit is suspected of historically restricting, although not preventing, vertical migration of liquid contaminants at the site. Because perched water was previously observed atop the Plio-Pleistocene unit, the unit is believed to potentially have retained other liquids and residues may still be present at some locations.

The judgmental sampling design will be evaluated to ensure that the characterization data generated will provide a sufficient basis for designation and disposal of investigation-derived waste generated during the well-deepening activity. To support this determination, a detailed analysis of the decisions for waste designation is undertaken and described in the following subsections. The judgmental soil sampling design described in Step 7 will be compared to the inputs required for waste designation to ensure that sufficient data are collected to support the waste management activity.

C.2 STEP 2 – IDENTIFY THE DECISION

As previously stated, no decisions regarding the site contaminant status will be made based on this characterization activity. In order to address the problem of waste designation, a series of principal study questions (PSQs) need to be answered. Table C-6 presents these PSQs along with the alternative actions that will be taken when each PSQ is answered. Each alternative action has the possibility of being an incorrect choice. The consequences of incorrectly choosing each alternative action are discussed, and a qualitative assessment of the severity of the consequences of incorrectly choosing each alternative action is also presented. For example, typically the consequence is defined as "severe" whenever human health may be impacted by the implementation of an incorrect alternative action. When project cost alone is impacted as a result of implementing an incorrect alternative action, the consequence may be "low," "moderate," or "severe," depending on the magnitude of the cost relative to the program budget. Finally, the PSQ and alternative action are combined into a decision statement.

Table C-6. Formulation of Decision Statements. (3 Pages)

PSQ AA#	Alternative Action	Consequences of Implementing an Incorrect Alternative Action	Severity of Consequences of an Incorrect Action (Low/Medium/High)
PSQ #1 -- Is the volumetric material radiologically contaminated?			
1-1	Dispose of material at the ERDF.	Unnecessary cost treating clean material as if it were contaminated.	Low to moderate
1-2	Dispose of material at the CWC.	Unnecessary cost treating clean material as if it were contaminated.	Low to moderate
1-3	No action.	Unspecified workplace exposure.	Low to moderate
DS #1 – Determine whether the radiological composition of the soil cuttings falls below ERDF waste acceptance criteria and can therefore be disposed of at the ERDF; otherwise, dispose of soil cuttings at the CWC.			
PSQ #2a -- Is the material a listed dangerous waste?			
2a-1	Decide the material is a listed dangerous waste and assign a listed dangerous waste code.	Unnecessary cost treating clean material as if it were contaminated.	Low to moderate
2a-2	Decide the material is not a listed dangerous waste and do not regulate as such.	Dangerous waste unknowingly placed in the ERDF or the CWC.	Moderate
2a-3	No action.	Dangerous waste unknowingly placed in the ERDF or the CWC.	Moderate
DS #2a – Determine whether the material is a listed dangerous waste and will be assigned a listed dangerous waste code OR whether the material is not a dangerous listed waste and will not be regulated as such.			
PSQ #2b -- Is the material a characteristic waste (e.g., ignitable, corrosive, reactive, or toxic)?			
2b-1	Decide the material is a characteristic waste and assign a characteristic waste code.	Unnecessary cost treating clean material as if it were contaminated.	Low to moderate
2b-2	Decide the material is not a characteristic waste and do not regulate as such.	Dangerous waste unknowingly placed in the ERDF or the CWC.	Moderate
2b-3	No action.	Dangerous waste unknowingly placed in the ERDF or the CWC.	Moderate
DS # 2b – Determine whether the material is a characteristic waste and will be assigned a characteristic waste code OR whether the material is not a characteristic waste and will not be regulated as such.			
PSQ #2c -- Is the material a toxic dangerous waste as defined by Washington State criteria?			
2c-1	Decide the material is a toxic dangerous waste and assign a toxic dangerous waste code.	Unnecessary cost treating clean material as if it were contaminated.	Low to moderate
2c-2	Decide the material is not a toxic dangerous waste and do not regulate as such.	Dangerous waste unknowingly placed in the ERDF or the CWC.	Moderate
2c-3	No action.	Dangerous waste unknowingly placed in the ERDF or the CWC.	Moderate
DS #2c – Determine whether material is a toxic dangerous waste and will be assigned a toxic dangerous waste code OR whether the material is not a toxic dangerous waste and will not be regulated as such.			

Table C-6. Formulation of Decision Statements. (3 Pages)

PSQ AA#	Alternative Action	Consequences of Implementing an Incorrect Alternative Action	Severity of Consequences of an Incorrect Action (Low/Medium/High)
PSQ #2d -- Is the material a persistent waste as defined by Washington State criteria?			
2d-1	Decide the material <u>is</u> a persistent waste and assign a persistent waste code.	Unnecessary cost treating clean material as if it were contaminated.	Low to moderate
2d-2	Decide the material <u>is not</u> a persistent waste and do not regulate as such.	Dangerous waste unknowingly placed in the ERDF or the CWC.	Moderate
2d-3	No action.	Dangerous waste unknowingly placed in the ERDF or the CWC.	Moderate
DS #2d – Determine whether the material is a persistent waste and will be assigned a persistent waste code OR whether the material is not a persistent waste and will not be regulated as such.			
PSQ #3 – Does the material's radiological activity exceed the disposal facility's waste acceptance criteria limits?			
3-1	Decide that the radiological activity of the material <u>does</u> exceed the disposal facility's waste acceptance criteria limits. Evaluate the waste for chemical waste designation and negotiate disposition with the regulators.	Unnecessary cost treating clean material as if it exceeded the waste acceptance criteria.	Low to moderate
3-2	Decide that the radiological activity of the material does not exceed the disposal facility acceptance limit and do not regulate as such.	Dangerous waste unknowingly placed in the ERDF or the CWC.	Moderate
3-3	No action.	Dangerous waste unknowingly placed in the ERDF or the CWC.	Moderate
DS #3 – Determine whether the material does exceed the disposal facility's waste acceptance criteria and disposal will be negotiated with the regulators <u>OR</u> whether the material does not exceed the disposal facility's waste acceptance criteria and waste will be disposed of in an approved facility.			
PSQ #4 – Is the material land disposal restricted?			
4-1	Decide the material is land disposal restricted and treat material prior to disposal.	Unnecessary cost treating clean material as if it were land disposal restricted.	Low to moderate
4-2	Decide that the material is not land disposal restricted and do not treat as such.	Dangerous waste unknowingly placed in ERDF or CWC.	Moderate
4-3	No action.	Dangerous waste unknowingly placed in ERDF or CWC.	Moderate
DS #4 – Determine whether the material is land disposal restricted and requires treatment before disposal <u>OR</u> whether the material is not land disposal restricted and may be disposed of without treatment.			
PSQ #5 – Does the land disposal restricted (treated) material meet universal treatment standards and disposal facility waste acceptance criteria limits?			

Table C-6. Formulation of Decision Statements. (3 Pages)

PSQ AA#	Alternative Action	Consequences of Implementing an Incorrect Alternative Action	Severity of Consequences of an Incorrect Action (Low/Medium/High)
5-1	Decide the land disposal restricted material <u>does</u> meet universal treatment standards and disposal facility waste acceptance criteria limits. Dispose of material in an approved facility.	Unnecessary cost treating clean material as if it were land disposal restricted.	Low to moderate
5-2	Decide the land disposal restricted material <u>does not</u> meet universal treatment standards and disposal facility waste acceptance criteria limits. Dispose of material in an approved facility. Conduct additional treatment and sampling prior to disposal.	Dangerous waste unknowingly placed in the ERDF or the CWC.	Moderate
5-3	No action.	Dangerous waste unknowingly placed in the ERDF or the CWC.	Moderate
DS #5 – Determine whether land disposal material (treated) does meet universal treatment standards and disposal facility waste acceptance criteria limits and will be disposed of in approved facility <u>OR</u> whether land disposal material (treated) does not meet universal treatment standards and disposal facility waste acceptance criteria limits and will require further treatment.			

AA = alternative action
CWC = Central Waste Complex
DS = decision statement

C.3 STEP 3 – IDENTIFY INPUTS TO THE DECISION

Information required to support the decisions identified in Section C.2 is described in the following sections.

C.3.1 Information Required to Resolve Decision Statements

Table C-7 identifies the decision statements where existing data either do not exist or are of insufficient quality to resolve the decision statements. For these decision statements, Table C-7 also presents computational and/or surveying/sampling methods that could be used to obtain the required data.

Table C-7. Information Required to Resolve the Decision Statements.

DS #	Information Needed	Required Data	Computational Methods	Survey/Sampling Methods
1	Information regarding contamination of volumetrically contaminated media relative to ERDF waste acceptance criteria	Radiological data in pCi/g or pCi/L.	N/A	Media sampling and analysis.
2a	Listed dangerous waste code status	No data required. Drill cuttings from the subject area are arbitrarily assigned listed waste code "F001."	N/A	Process knowledge.
2b	Compare waste to ERDF waste acceptance criteria for characteristic waste	Sampling and analysis data.	N/A	Media sampling and analysis.
2c	Compare waste to ERDF waste acceptance criteria for toxic dangerous waste	Analytical data, reference evaluation.	Evaluation of sampling and analysis results in accordance with WAC 173-303.	N/A
2d	Compare waste to ERDF waste acceptance criteria for persistent waste	Sampling and analysis data.	Evaluation of sampling and analysis results in accordance with WAC 173-303.	N/A
3	Information regarding compliance with disposal facility's radiological waste acceptance criteria	Radiological survey and/or sampling and analysis data.	N/A	Radiological survey and/or sampling and analysis data.
4	Compare waste to ERDF waste acceptance criteria for land disposal restricted materials	Process knowledge and/or analytical data.	N/A	Process knowledge, investigation, or media sampling and analysis.
5	Compare waste to ERDF requirements for compliance with universal treatment standards and disposal facility waste acceptance criteria	Sampling and analysis data.	N/A	Sampling and analysis of treated waste.

N/A = not applicable

C.3.2 Analytical Performance Requirements

Table C-8 defines the analytical performance requirements for the data that need to be collected to resolve the decision statements. These performance requirements include the contract-required detection level and precision and accuracy for each of the COCs. Action levels are also given for each COC.

Table C-8. Analytical Performance Requirements and Action Levels. (3 Pages)

	COC	Survey or Analytical Method	ERDF Waste Action Level[a]	Universal Treatment Standard[b]	CRDL	Precision Required	Accuracy Required
Metals	Antimony	SW-846 6010	NA	2.1 mg/L	8 mg/kg	±30%	±20%
	Arsenic	SW-846 6010	100.0 mg/kg[c]	5 mg/L	1.0 mg/kg	±30%	±20%
	Barium	SW-846 6010	2000.0 mg/kg[c]	7.6 mg/L	35 mg/kg	±30%	±20%
	Beryllium	SW-846 6010	NA	0.014 mg/L	0.001 mg/kg	±30%	±20%
	Cadmium	SW-846 6010	20 mg/kg[c]	0.19 mg/L	0.5 mg/kg	±30%	±20%
	Chromium Total	SW-846 6010	100 mg/kg[c]	0.86 mg/L	4 mg/kg	±30%	±20%
	Lead	SW-846 6010	100 mg/kg[c]	0.37 mg/L	1.0 mg/kg	±30%	±20%
	Mercury	SW-846 7471 (cold vapor)	4 mg/kg[c]	0.25 mg/L	0.02 mg/kg	±30%	±20%
	Nickel	SW-846 6010	NA	5 mg/L	8 mg/kg	±30%	±20%
	Selenium	SW-846 6010	20 mg/kg[c]	0.16 mg/L	3 mg/kg	±30%	±20%
	Silver	SW-846 6010	100 mg/kg[c]	0.3 mg/L	3 mg/kg	±30%	±20%
	Vanadium	SW-846 6010	NA	0.23 mg/L	3 mg/kg	±30%	±20%
	Zinc	SW-846 6010	NA	5.3 mg/L	30 mg/kg	±30%	±20%
Radio-nuclides	Gross alpha	Alpha scintillation	NA	NA	3 pCi/g	±30%	±3σ
	Gross beta	Gas proportional counting	NA	NA	5 pCi/g	±30%	±3σ
	Am-241	Alpha spectroscopy	1,560 pCi/g[d]	NA	10 pCi/g	±30%	±3σ
	Co-60	Gamma spectroscopy	3.81 E+06 pCi/g[d]	NA	10 pCi/g	±30%	±3σ
	Cs-137	Gamma spectroscopy	2.67 E+07 pCi/g[d]	NA	10 pCi/g	±30%	±3σ
	Pu-238	Alpha spectroscopy	1,000 pCi/g[d]	NA	10 pCi/g	±30%	±3σ
	Pu-239/240	Alpha spectroscopy	6,220 pCi/g[d]	NA	10 pCi/g	±30%	±3σ

Table C-8. Analytical Performance Requirements and Action Levels. (3 Pages)

	COC	Survey or Analytical Method	ERDF Waste Action Level[a]	Universal Treatment Standard[b]	CRDL	Precision Required	Accuracy Required
Radio-nuclides (cont.)	Pu-241	Alpha spectroscopy	60,600 pCi/g[d]	NA	15 pCi/g	±30%	±3σ
	Sr-90	Chemical separation/beta proportional count	3.57E+9 pCi/g[d]	NA	1 pCi/g	+ 30%	±3σ
	Np-237	Chemical separation/ alpha count	765 pCi/g[d]	NA	1 pCi/g	+ 30%	±3σ
	Sb-125	Gamma spectroscopy or LSC	1,920 pCi/g[d]	NA	50 pCi/g	±30%	±3σ
VOCs	Trans 1,2-DCE	SW-846 8260	NA	30 mg/kg	5 mg/kg	±30%	±20%
	1,1-DCA	SW-846 8260	NA	6 mg/kg	2 mg/kg	±30%	±20%
	cis-1,2-DCE	SW-846 8260	NA	NA	3 mg/kg	±30%	±20%
	Chloroform	SW-846 8260	120 mg/kg[c]	6 mg/kg	0.3 mg/kg	±30%	±20%
	1,2-dichloroethane	SW-846 8260	10 mg/kg[c]	6 mg/kg	0.01 mg/kg	±30%	±20%
	Benzene	SW-846 8260	10 mg/kg[c]	10 mg/kg	0.05 mg/kg	±30%	±20%
	Ethylbenzene	SW-846 8260	NA	10 mg/kg	3 mg/kg	±30%	±20%
	Carbon tetrachloride	SW-846 8260	10 mg/kg[c]	6 mg/kg	0.01 mg/kg	±30%	±20%
	PCE	SW-846 8260	14 mg/kg[c]	6 mg/kg	0.03 mg/kg	±30%	±20%
	TCE	SW-846 8260	10 mg/kg[c]	6 mg/kg	0.1 mg/kg	±30%	±20%
	M-xylene	SW-846 8260	NA	30 mg/kg[e]	10 mg/kg	±30%	±20%
	O-xylene	SW-846 8260	NA	30 mg/kg[e]	10 mg/kg	±30%	±20%
	P-xylene	SW-846 8260	NA	30 mg/kg[e]	10 mg/kg	±30%	±20%
	Toluene	SW-846 8260	NA	10 mg/kg	3 mg/kg	±30%	±20%

Table C-8. Analytical Performance Requirements and Action Levels. (3 Pages)

	COC	Survey or Analytical Method	ERDF Waste Action Level[a]	Universal Treatment Standard[b]	CRDL	Precision Required	Accuracy Required
VOCs (cont.)	1,1,1 trichloroethane	SW-846 8260	NA	6 mg/kg	2 mg/kg	±30%	±20%
	Methylene chloride	SW-846 8260	NA	30 mg/kg	0.2 mg/kg	±30%	±20%
	Acetone	SW-846 8260	NA	160 mg/kg	25 mg/kg	±30%	±20%
	Methyl isobutyl ketone	SW-846 8260	NA	33 mg/kg	10 mg/kg	±30%	±20%
SVOCs	Tributyl phosphate	SW-846 8270	10,000 mg/kg[f] (1%)	NA	100 mg/kg	±30%	±20%
	Phenol	SW-846 8270	NA	6.2 mg/kg	2 mg/kg	±30%	±20%
Miscel-laneous	Lard oil	EPA 413.2 (oil and grease, hexane extraction with gravimetric determination)	NA	NA	100 mg/kg	±30%	±20%

[a] Action levels based on waste characteristics, dangerous waste criteria, and ERDF safety authorization basis
[b] Universal treatment standards, 40 CFR 268.48.
[c] Based on toxic characteristic leachate procedure value times 20 to get soil concentration.
[d] ERDF safety authorization basis.
[e] Sum of o-, m-, and p-xylene concentrations.
[f] Tributyl phosphate is a WT02 waste, toxic category D, and is regulated at concentrations of 1% or more.
CRDL = contract-required detection limit
LCS = liquid scintillation counting
NA = not applicable

The radiological composition of the soil samples for waste disposition purposes will initially be evaluated for radionuclides, gross alpha and gross beta activity, and the metals, VOCs, and semi-volatile organic compounds (SVOCs) identified in Table C-8.

C.4 STEP 4 – DEFINE THE BOUNDARIES OF THE STUDY

Site characterization sampling and analysis will be conducted on soil and soil vapor samples removed from the boreholes during well deepening. The boundaries of the waste designation study are confined to the drill cuttings generated from the two existing wells by deepening the wells from their current total depth of approximately 30.5 m (100 ft) below ground surface to a new total depth of approximately 61 m (200 ft) below ground surface. Waste will be generated during a discrete period of field operations anticipated to occur during the spring of 2001.

C.5 STEP 5 – DEVELOP DECISION RULES

Table C-9 presents the decision rules that correspond to each of the decision statements regarding waste designation identified in Table C-6.

Table C-9. Decision Rules.

DR #	Decision Rule
1	If the maximum measured values from radiological analytical results for volumetrically contaminated materials exceed corresponding action levels (see Table C-8), then dispose of material at the CWC; otherwise, dispose of material in the ERDF.
2a through 2d	If the maximum measured analysis values of samples representing the contents of container(s) indicate that the materials <u>are</u> to be designated as listed dangerous, characteristic, toxic dangerous, persistent, or polychlorinated biphenyl, then materials will be evaluated for treatment as per DR #3 through DR #5. If the maximum measured analysis values of samples representing the contents of container(s) indicate that the materials <u>are not</u> to be designated as listed dangerous, characteristic, toxic dangerous, persistent, polychlorinated biphenyl, or asbestos waste, then materials will be released for offsite recycle, reuse, or clean landfill disposal.
3	If the maximum measured analysis values of samples representing the contents of container(s) for volumetrically contaminated materials exceed corresponding action levels (see Table C-8), then dispose of material at the CWC; otherwise, dispose of material in the ERDF.
4	If process knowledge or any detected sample value dictates land disposal restriction-imposed treatment, then the materials will be treated and evaluated for disposal according to DR #5. If process knowledge or none of the detected sample values dictate land disposal restriction-imposed treatment of the materials, then the materials will be disposed of in the ERDF.
5	If all detected analytical sample values indicate that treated materials <u>do meet</u> the universal treatment standards and disposal facility waste acceptance criteria limits, then the treated materials will be disposed of in the ERDF. If any detected analytical sample values indicate that treated materials <u>do not meet</u> the universal treatment standards and disposal facility waste acceptance criteria limits, then the treated materials may require additional treatment and sampling prior to disposal.

DR = decision rule

C.6 STEP 6 – SPECIFY TOLERABLE LIMITS ON DECISION ERRORS

Because the waste expected to be generated by this activity is assumed to be contaminated, and a judgmental sampling design is anticipated, no limits on decision errors can be computed.

C.7 STEP 7 – OPTIMIZE THE DESIGN

Because the waste material resulting from drilling operations will either be disposed of at ERDF or the Central Waste Complex, as opposed to returning soil cuttings to the ground surface, there is no need to evaluate the data statistically for either the radiological or chemical composition of the waste as the maximum result will be used.

C.7.1 Sampling Design

The planned judgmental sampling design for the supplemental site characterization is evaluated to determine whether the design will provide sufficient information to support waste designation. The sampling design is described below.

The vadose zone characterization during the well-deepening activity is driven by the desire to collect additional information regarding the site-related contaminants located above, within, and beneath the Plio-Pleistocene layer at this site. The contaminants identified as COCs for this site based on historic release information and waste management requirements. Relatively intensive sampling across the Plio-Pleistocene layer with less intense sampling in the vadose beneath the Plio-Pleistocene layer and measurement of VOCs in soil vapor at discrete levels across the drilled interval will provide enhanced information regarding site contaminants. These objectives will be achieved by collecting split-spoon samples for laboratory analysis at selected intervals during drilling and by collecting soil vapor samples from the borehole(s) at discrete levels using an inflatable packer and air pump. The VOC concentration in soil vapor samples will be determined in the field using a field instrument. The qualitative nature of soil vapors at this site has been previously characterized during SVE operations; therefore, use of the field instrumentation available at the site will provide representative data on the distribution of VOCs in the boreholes.

The sampling design is focused on identifying the vertical distribution of contaminants across the Plio-Pleistocene layer and underlying material to the planned depth of the borings.

Vadose zone characterization will consist of collection and analysis of subsurface soil samples at selected intervals and measurement of soil vapor samples from selected elevations during drilling. The Plio-Pleistocene unit forms a substantial restricting layer to vertical migration of liquids and dissolved/suspended contaminants at the Z-9 Trench. Perched water atop the Plio-Pleistocene has been observed in several wells in the vicinity. The Plio-Pleistocene unit and the soil immediately overlying it, therefore, are expected to exhibit elevated contaminant concentration. The strategy for sampling soil and soil vapor during the well-deepening activity is a follows:

- Collect soil vapor samples at the selected elevations, in the Hanford formation immediately above the Plio-Pleistocene, midway through the Plio-Pleistocene, and immediately beneath the Plio-Pleistocene unit. Soil vapor samples will then be collected at approximately 6-m (20-ft) intervals to the bottom of the boring

- Collect continuous split-spoon soil samples from the elevation immediately overlying the Plio-Pleistocene unit through the full thickness of the Plio-Pleistocene (approximately 12 split spoons per boring)

- Collect split-spoon soil samples from the Ringold Formation at 3-m (10-ft) intervals from the bottom of the Plio-Pleistocene to the top of the planned screened interval (approximately six split spoons per boring)

- Collect split-spoon soil samples from the top, middle, and bottom of the screened interval (three split spoons per boring).

The sampling approach will provide a thorough description of contaminant conditions across the vertical extent of the borings.

The number of samples planned for collection and analysis during drilling substantially exceeds the minimum number of samples required for waste designation purposes. The number of sample analyses that will be available and the systematic judgmental approach to sample collection will ensure that the characterization data bracket the expected maximum contaminant concentrations in the sampled area.

C.8 REFERENCES

40 CFR 268, "Land Disposal Restrictions," *Code of Federal Regulations*, as amended.

BHI-EE-10, *Waste Management Plan*, Bechtel Hanford, Inc., Richland, Washington.

DOE-RL, 2000, *Waste Management Plan for the Expedited Response Action for 200 West Area Carbon Tetrachloride Plume and the 200-ZP-1 Operable Unit*, DOE/RL-2000-40, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Ludowise, J. D., 1978, *Report on Plutonium Mining Activities at 216-Z-9 Enclosed Trench*, RHO-ST-21, Rockwell Hanford Operations, Richland, Washington.

PNL, 1993, *Refined Conceptual Model for the Volatile Organic Compounds -- Arid Integrated Demonstration and 200 West Area Carbon Tetrachloride Expedited Response Action*, PNL-8597, Pacific Northwest Laboratory, Richland, Washington.

Smith, A. E., 1973, *Nuclear Reactivity Evaluations of 216-Z-9 Enclosed Trench, December 1973*, ARH-2915, Atlantic Richfield Hanford Company, Richland, Washington.

WAC 173-303, "Dangerous Waste Regulations," *Washington Administrative Code*, as amended.

WAC 173-340, "Model Toxics Control Act – Cleanup," *Washington Administrative Code*, as amended.

WHC, 1994, *1994 Conceptual Model of the Carbon Tetrachloride Contamination in the 200 West Area at the Hanford Site*, WHC-SD-EN-TI-248, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

APPENDIX D

ANALYTICAL LABORATORY PERFORMANCE REQUIREMENTS

Table D-1. Analytical Laboratory Performance Requirements. (5 Pages)

Service List Name	CAS#	Long Name	RDL Water	RDL Soil/Other	Precision Water	Accuracy Water	Precision Soil	Accuracy Soil
Radionuclides (all units as pCi/L (water) or pCi/g (soil/other) unless noted otherwise)								
Gross alpha/beta - 9310	12587-46-1	Gross alpha	3	10				
Gross alpha/beta - 9310	12587-47-2	Gross beta	4	15	+-20%	70-130%	+-35%	70-130%
Gamma spec	10045-97-3	Cesium-137	15	0.1	+-20%	70-130%	+-35%	70-130%
Gamma spec	10198-40-0	Cobalt-60	25	0.05	+-20%	70-130%	+-35%	70-130%
	14234-35-6	Antimony-125	50	0.5	+-20%	70-130%	+-35%	70-130%
Americium-241	14596-10-2	Americium-241	1	1	+-20%	70-130%	+-35%	70-130%
Isotopic plutonium	13981-16-3	Plutonium-238	1	1	+-20%	70-130%	+-35%	70-130%
Isotopic plutonium	PU-239/240	Plutonium-239/240	1	1	+-20%	70-130%	+-35%	70-130%
Chemical (all units as µg/L (water) or µg/kg (soil/other) unless noted otherwise)								
Inorganic								
ICP Metals – 6010	7429-90-5	Aluminum	200	20000	a	a	a	a
ICP Metals – 6010	7439-89-6	Iron	100	10000	a	a	a	a
ICP Metals – 6010	7439-95-4	Magnesium	5000	500000	a	a	a	a
ICP Metals – 6010	7439-96-5	Manganese	15	1500	a	a	a	a
ICP Metals – 6010	7440-02-0	Nickel	40	4000	a	a	a	a
ICP Metals – 6010	7440-09-7	Potassium	5000	500000	a	a	a	a
ICP Metals – 6010	7440-22-4	Silver	20	2000	a	a	a	a
ICP Metals – 6010	7440-23-5	Sodium	5000	500000	a	a	a	a
ICP Metals – 6010	7440-36-0	Antimony	60	6000	a	a	a	a
ICP Metals – 6010	7440-39-3	Barium	200	20000	a	a	a	a
ICP Metals – 6010	7440-41-7	Beryllium	5	500	a	a	a	a
ICP Metals – 6010	7440-43-9	Cadmium	5	500	a	a	a	a
ICP Metals – 6010	7440-47-3	Chromium	10	1000	a	a	a	a
ICP Metals – 6010	7440-48-4	Cobalt	50	5000	a	a	a	a
ICP Metals – 6010	7440-50-8	Copper	25	2500	a	a	a	a
ICP Metals – 6010	7440-62-2	Vanadium	50	5000	a	a	a	a
ICP Metals – 6010	7440-66-6	Zinc	20	2000	a	a	a	a

Table D-1. Analytical Laboratory Performance Requirements. (5 Pages)

Service List Name	CAS#	Long Name	RDL Water	RDL Soil/Other	Precision Water	Accuracy Water	Precision Soil	Accuracy Soil
ICP Metals – 6010	7440-70-2	Calcium	5000	500000	a	a	a	a
ICP Metals – 6010	7439-92-1	Lead	100	10000	a	a	a	a
Mercury – 7470	7439-97-6	Mercury	0.5	NA	a	a	a	a
Mercury – 7471	7439-97-6	Mercury	NA	200	a	a	a	a
Organics								
Volatile organics – 8260	100-41-4	Ethylbenzene	5	5	a	a	a	a
Volatile organics – 8260	100-42-5	Styrene	5	5	a	a	a	a
Volatile organics – 8260	10061-01-5	cis-1,3-Dichloropropene	5	5	a	a	a	a
Volatile organics – 8260	10061-02-6	trans-1,3-Dichloropropene	5	5	a	a	a	a
Volatile organics – 8260	107-06-2	1,2-Dichloroethane	5	5	a	a	a	a
Volatile organics – 8260	108-10-1	4-Methyl-2-Pentanone	10	10	a	a	a	a
Volatile organics – 8260	108-88-3	Toluene	5	5	a	a	a	a
Volatile organics – 8260	108-90-7	Chlorobenzene	5	5	a	a	a	a
Volatile organics – 8260	124-48-1	Dibromochloromethane	5	5	a	a	a	a
Volatile organics – 8260	127-18-4	Tetrachloroethene	5	5	a	a	a	a
Volatile organics – 8260	1330-20-7	Xylenes (total)	10	10	a	a	a	a
Volatile organics – 8260	540-59-0	1,2-Dichloroethene (total)	10	10	a	a	a	a
Volatile organics – 8260	56-23-5	Carbon tetrachloride	5	5	a	a	a	a
Volatile organics – 8260	591-78-6	2-Hexanone	20	20	a	a	a	a
Volatile organics – 8260	67-64-1	Acetone	20	20	a	a	a	a
Volatile organics – 8260	67-66-3	Chloroform	5	5	a	a	a	a
Volatile organics – 8260	71-43-2	Benzene	5	5	a	a	a	a
Volatile organics – 8260	71-55-6	1,1,1-Trichloroethane	5	5	a	a	a	a
Volatile organics – 8260	74-83-9	Bromomethane	10	10	a	a	a	a
Volatile organics – 8260	74-87-3	Chloromethane	10	10	a	a	a	a
Volatile organics – 8260	75-00-3	Chloroethane	10	10	a	a	a	a
Volatile organics – 8260	75-01-4	Vinyl chloride	10	10	a	a	a	a
Volatile organics – 8260	75-09-2	Methylenechloride	5	5	a	a	a	a
Volatile organics – 8260	75-15-0	Carbon disulfide	5	5	a	a	a	a

Table D-1. Analytical Laboratory Performance Requirements. (5 Pages)

Service List Name	CAS#	Long Name	RDL Water	RDL Soil/Other	Precision Water	Accuracy Water	Precision Soil	Accuracy Soil
Volatile organics – 8260	75-25-2	Bromoform	5	5	a	a	a	a
Volatile organics – 8260	75-27-4	Bromodichloromethane	5	5	a	a	a	a
Volatile organics – 8260	75-34-3	1,1-Dichloroethane	10	10	a	a	a	a
Volatile organics – 8260	75-35-4	1,1-Dichloroethene	10	10	a	a	a	a
Volatile organics – 8260	78-87-5	1,2-Dichloropropane	5	5	a	a	a	a
Volatile organics – 8260	78-93-3	2-Butanone	10	10	a	a	a	a
Volatile organics – 8260	79-00-5	1,1,2-Trichloroethane	5	5	a	a	a	a
Volatile organics – 8260	79-01-6	Trichloroethene	5	5	a	a	a	a
Volatile organics – 8260	79-34-5	1,1,2,2-Tetrachloroethane	5	5	a	a	a	a
Semi-volatiles – 8270	100-01-6	4-Nitroaniline	10	330	a	a	a	a
Semi-volatiles – 8270	100-02-7	4-Nitrophenol	20	660	a	a	a	a
Semi-volatiles – 8270	101-55-3	4-Bromophenylphenyl ether	10	330	a	a	a	a
Semi-volatiles – 8270	105-67-9	2,4-Dimethylphenol	10	330	a	a	a	a
Semi-volatiles – 8270	106-44-5	4-Methylphenol (cresol, p-)	10	330	a	a	a	a
Semi-volatiles – 8270	106-46-7	1,4-Dichlorobenzene	10	330	a	a	a	a
Semi-volatiles – 8270	106-47-8	4-Chloroaniline	10	330	a	a	a	a
Semi-volatiles – 8270	108-60-1	2,2'-Oxybis(1-chloropropane)	10	330	a	a	a	a
Semi-volatiles – 8270	108-95-2	Phenol	10	330	a	a	a	a
Semi-volatiles – 8270	111-44-4	Bis(2-chloroethyl) ether	10	330	a	a	a	a
Semi-volatiles – 8270	111-91-1	Bis(2-Chloroethoxy)methane	10	330	a	a	a	a
Semi-volatiles – 8270	117-81-7	Bis(2-ethylhexyl) phthalate	10	330	a	a	a	a
Semi-volatiles – 8270	117-84-0	Di-n-octylphthalate	10	330	a	a	a	a
Semi-volatiles – 8270	118-74-1	Hexachlorobenzene	10	330	a	a	a	a
Semi-volatiles – 8270	120-12-7	Anthracene	10	330	a	a	a	a
Semi-volatiles – 8270	120-82-1	1,2,4-Trichlorobenzene	10	330	a	a	a	a
Semi-volatiles – 8270	120-83-2	2,4-Dichlorophenol	10	330	a	a	a	a
Semi-volatiles – 8270	121-14-2	2,4-Dinitrotoluene	10	330	a	a	a	a
Semi-volatiles – 8270	129-00-0	Pyrene	10	330	a	a	a	a
Semi-volatiles – 8270	131-11-3	Dimethyl phthalate	10	330	a	a	a	a

Table D-1. Analytical Laboratory Performance Requirements. (5 Pages)

Service List Name	CAS#	Long Name	RDL Water	RDL Soil/Other	Precision Water	Accuracy Water	Precision Soil	Accuracy Soil
Semi-volatiles – 8270	132-64-9	Dibenzofuran	10	330	a	a	a	a
Semi-volatiles – 8270	191-24-2	Benzo(ghi)perylene	10	330	a	a	a	a
Semi-volatiles – 8270	193-39-5	Indeno(1,2,3-cd)pyrene	10	330	a	a	a	a
Semi-volatiles – 8270	205-99-2	Benzo(b)fluoranthene	10	330	a	a	a	a
Semi-volatiles – 8270	206-44-0	Fluoranthene	10	330	a	a	a	a
Semi-volatiles – 8270	207-08-9	Benzo(k)fluoranthene	10	330	a	a	a	a
Semi-volatiles – 8270	208-96-8	Acenaphthylene	10	330	a	a	a	a
Semi-volatiles – 8270	218-01-9	Chrysene	10	330	a	a	a	a
Semi-volatiles – 8270	50-32-8	Benzo(a)pyrene	10	330	a	a	a	a
Semi-volatiles – 8270	51-28-5	2,4-Dinitrophenol	25	825	a	a	a	a
Semi-volatiles – 8270	53-70-3	Dibenz[a,h]anthracene	10	330	a	a	a	a
Semi-volatiles – 8270	534-52-1	4,6-Dinitro-2methyl phenol	10	330	a	a	a	a
Semi-volatiles – 8270	541-73-1	1,3-Dichlorobenzene	10	330	a	a	a	a
Semi-volatiles – 8270	56-55-3	Benzo(a)anthracene	10	330	a	a	a	a
Semi-volatiles – 8270	59-50-7	4-Chloro-3-methylphenol	10	330	a	a	a	a
Semi-volatiles – 8270	606-20-2	2,6-Dinitrotoluene	10	330	a	a	a	a
Semi-volatiles – 8270	621-64-7	N-Nitroso-di-n-dipropylamine	10	330	a	a	a	a
Semi-volatiles – 8270	67-72-1	Hexachloroethane	10	330	a	a	a	a
Semi-volatiles – 8270	7005-72-3	4-Chlorophenylphenyl ether	10	330	a	a	a	a
Semi-volatiles – 8270	77-47-4	Hexachlorocyclopentadiene	10	330	a	a	a	a
Semi-volatiles – 8270	78-59-1	Isophorone	10	330	a	a	a	a
Semi-volatiles – 8270	83-32-9	Acenaphthene	10	330	a	a	a	a
Semi-volatiles – 8270	84-66-2	Diethylphthalate	10	330	a	a	a	a
Semi-volatiles – 8270	84-74-2	Di-n-butylphthalate	10	330	a	a	a	a
Semi-volatiles – 8270	85-01-8	Phenanthrene	10	330	a	a	a	a
Semi-volatiles – 8270	85-68-7	Butylbenzylphthalate	10	330	a	a	a	a
Semi-volatiles – 8270	86-30-6	N-Nitrosodiphenylamine	10	330	a	a	a	a
Semi-volatiles – 8270	86-73-7	Fluorene	10	330	a	a	a	a
Semi-volatiles – 8270	86-74-8	Carbazole	10	330	a	a	a	a

Table D-1. Analytical Laboratory Performance Requirements. (5 Pages)

Service List Name	CAS#	Long Name	RDL Water	RDL Soil/Other	Precision Water	Accuracy Water	Precision Soil	Accuracy Soil
Semi-volatiles – 8270	87-68-3	Hexachlorobutadiene	10	330	a	a	a	a
Semi-volatiles – 8270	87-86-5	Pentachlorophenol	10	330	a	a	a	a
Semi-volatiles – 8270	88-06-2	2,4,6-Trichlorophenol	10	330	a	a	a	a
Semi-volatiles – 8270	88-74-4	2-Nitroaniline	10	330	a	a	a	a
Semi-volatiles – 8270	88-75-5	2-Nitrophenol	20	660	a	a	a	a
Semi-volatiles – 8270	91-20-3	Naphthalene	10	330	a	a	a	a
Semi-volatiles – 8270	91-57-6	2-Methylnaphthalene	10	330	a	a	a	a
Semi-volatiles – 8270	91-58-7	2-Chloronaphthalene	10	330	a	a	a	a
Semi-volatiles – 8270	91-94-1	3,3'-Dichlorobenzidine	10	330	a	a	a	a
Semi-volatiles – 8270	95-48-7	2-Methylphenol (cresol, o-)	10	330	a	a	a	a
Semi-volatiles – 8270	95-50-1	1,2-Dichlorobenzene	10	330	a	a	a	a
Semi-volatiles – 8270	95-57-8	2-Chlorophenol	10	330	a	a	a	a
Semi-volatiles – 8270	95-95-4	2,4,5-Trichlorophenol	10	330	a	a	a	a
Semi-volatiles – 8270	98-95-3	Nitrobenzene	10	330	a	a	a	a
Semi-volatiles – 8270	99-09-2	3-Nitroaniline	10	330	a	a	a	a
Semi-volatiles – 8270	126-73-8	Tributyl phosphate	100	3300	a	a	a	a
Oil and grease - 413.2	NA	Non-specific extractables	NA	100,000	NA	NA	80% RPD	+/- 20% Rec

[a] Precision and accuracy requirements as identified and defined in the referenced EPA procedures.

CAS = chemical abstract services

ICP = inductively coupled plasma

NA = not applicable

RDL = required detection limit

RPD = relative percent different

DISTRIBUTION

U.S. Department of Energy
Richland Operations Office

J. G. Morse	A5-13
K. M. Thompson	A5-13
A. C. Tortoso	H0-12 (15)

ERC Team

K. A. Anselm, CHI	H9-03
J. V. Borghese, CHI	H0-19
L. R. Curry, BHI	H0-21
G. A. Day, BHI	H0-19
R. J. Fabre, BHI	X5-50
K. R. Fecht, BHI	H0-02
R. L. Jackson, BHI	H0-19 (5)
M. N. Jarayssi, BHI	H0-19
T. A. Lee, CHI	H9-02
C. W. Miller, CHI	H9-03 (2)
G. B. Mitchem, BHI	H0-21
W. H. Price, BHI	H0-18
V. J. Rohay, CHI	H0-19
L. C. Swanson, CHI	H9-02
D. C. Weekes, CHI	H9-02

PNNL

F. J. Brockman	P7-50
R. J. Cameron	K6-96
K. B. Olsen	K6-96
Document and Information Services (3)	H0-09
DOE-RL Public Reading Room	H2-53
Hanford Technical Library	P8-55